DOCUMENT RESUME

ED 420 496 SE 061 479

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TITLE Environmental Education Teachers Manual. Environmental Education Issues in the Pacific.
INSTITUTION Peace Corps, Washington, DC. Information Collection and Exchange Div.
REPORT NO R0102
PUB DATE 1996-02-00
NOTE 143p.
AVAILABLE FROM Peace Corps, Information Collection and Exchange, 1990 K Street NW, 8th Floor, Washington, DC 20526.
PUB TYPE Guides - Classroom - Teacher (052)
EDRS PRICE MF01/PC06 Plus Postage.
DESCRIPTORS Agriculture; *Conservation (Environment); *Developing Nations; Elementary Secondary Education; *Environmental Education; Foreign Countries; Interdisciplinary Approach; *Learning Activities; Quality of Life; *Sustainable Development; Teacher Education Programs; Teaching Guides; Workshops
IDENTIFIERS Environmental Awareness; *Pacific Islands

ABSTRACT

This teacher's manual was developed to provide information on environmental education issues in the Pacific to teachers, extension officers, and other trainers to help make conservation an integral part of their teaching and training activities. The main focus of the activities contained in this manual is to achieve sustainability and enhance the long-term quality of life in the South Pacific. The emphasis throughout is on learning by doing. The manual is divided into four units. The first unit, "Teacher Training for Environmental Education", gives suggestions for teacher training, describes a teacher training workshop and activities, and offers tips for integrating environmental education activities into existing curricula using an interdisciplinary approach. Many of the teacher education activities in this manual may also be appropriate for use in the classroom. The other three units--"Marine Environment", "Pollution", and "Agriculture"--are comprised of classroom activities on those themes and include an overview and activities. Activities address such topics as coastal environment, coral reefs, nuclear pollution, pesticides, development, and changing agricultural practices. Scientific concepts addressed include tides and waves, soil erosion, and water salinity. (PVD)

Environmental Education Teachers Manual

Environmental Education Issues in the Pacific

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Environmental Education Teachers Manual

Environmental Education Issues in the Pacific

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February 1996
R0102

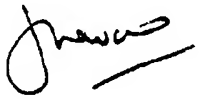
Foreword

The key focus of activities in this Teachers Manual is to achieve sustainability, and so enhance the long-term quality of life in the South Pacific.

I commend this book as it offers suggestions rather than a prescription for teacher training in environmental education. Youth workers, community workers and other extension agents will also find value in this Manual and see it is appropriate to their needs. It also brings together a number of teaching activities to improve environmental education in the region.

The manual represents a major contribution in conceptualizing SPREP's role in how to use education to achieve sustainable development in Pacific Island countries.

I hope that you will find this Teachers Manual helpful to your own role in helping achieve this sustainability.



Vili A. Fuavao
Director

Preface

This ***Environmental Education Teachers Manual*** was written by teachers and curriculum developers from the various Education Departments of the South Pacific Region together with government officers involved in community environmental awareness raising. The preliminary draft was produced at the region's first Environmental Education Curriculum Workshop held in Suva, Fiji, 1 - 14 July 1988. This Workshop was jointly organised by the South Pacific Regional Environment Programme (SPREP) of the South Pacific Commission, Noumea, New Caledonia, and the Institute of Education (IOE) of the University of the South Pacific (USP), Suva, Fiji, with financial assistance from the United Nations Environment Programme (UNEP), Nairobi, Kenya.

Subsequent drafts of this Manual were revised by the workshop participants in an extensive exercise of mail contact, resulting in this final product. SPREP, IOE and UNEP would like to thank the following people for their dedication to this work:

- Bev Abbott, New Zealand
- Rick Davis, American Samoa
- Avril Inay, Guam
- Taukeke Karotu, Kiribati
- Nofoaiga Lafita, Tuvalu
- Demei Otobed, Palau
- Manu Puloka, Tonga
- Harvey Segal, Federated States of Micronesia
- William Swain, Marshall Islands
- Bernadette Ahi, Papua New Guinea
- Martin Horrocks, Vanuatu
- Konrote Isimeli, Fiji
- Marilyn Vander Weide, Guam
- Roderick MacKenzie, American Samoa
- Nuufou Petaia, Western Samoa
- Vaitoti Tupa, Cook Islands
- Asenaca Ravuvu, Fiji
- Weldis Welley, Federated States of Micronesia.

Valuable assistance and information was also provided by various other people connected with the *Environmental Education Curriculum Workshop*, many of whom were staff of the University of the South Pacific, namely:

- Bill Aalbersberg
- Jenny Bryant
- Doug Hill (Visiting Fellow)
- Milika Naqasima
- Randy Thaman
- Mark Merlin (Hawaii)
- Narottam Bhindi
- Sarojni Choy
- John Morrison
- Konai Thaman
- Ruby Va'a
- Dennis Keene (Hawaii)

together with:

- Michael Atchia, Head of UNEP's Environmental Education and Training Unit;
- Pita Nacuva, Director, Fiji Government's Directorate of Town and Country Planning;
- Birandra Singh of the National Trust for Fiji; and
- Iosefatu Reti, then Co-ordinator of the South Pacific Regional Environment Programme (SPREP).

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Contents

The Purpose of this Teachers Manual

Introduction

This Environmental Education Teachers Manual was developed to provide information on *Environmental Education Issues in the Pacific* to teachers, extension officers and other trainers to help them make conservation an integral part of their teaching and training activities, and thus of all Pacific Island development. There is very little published material to assist teachers in undertaking environmental education activities with their classes and there is especially a lack of school material specifically about the environment of the South Pacific. This manual has been produced to help fill this gap.

Further, it is well recognised that it would be unrealistic to expect teachers to incorporate environmental content into their lessons without first giving them specific **training** in environmental education. The **South Pacific Regional Environment Programme** (SPREP) has thus obtained funding from the **International Centre for Ocean Development** (ICOD) to enable it to run a series of Teacher Training Workshops in several countries of the South Pacific region.

This Manual which will be used as the basic source material at these in-country workshops, was produced also with ICOD funding. The initial draft of the Manual was prepared in 1988 by the teachers, curriculum developers and others (see Preface for the full list) who participated in the Environmental Education Curriculum Workshop, Suva, Fiji and has now been finalised in readiness for teacher training to commence in 1991.

It is hoped that this additional training will strengthen teachers' environmental education knowledge and enhance their confidence in undertaking class activities which demonstrate the value of environmental protection and the need for increased student knowledge of their environment. Specifically it is hoped:

- to increase teachers' awarenenss of environmental issues;
- to develop teachers' skills which can be used in environmental education; and
- to increase teachers' commitment to environmental education and, if appropriate, to suggest strategies they can use to influence other teachers.

What is Meant by "Environment"?

Environment refers to all our surroundings - the air we breathe; the soil we grow our plants in; the water we drink, fish and swim in; and the plants and animals that surround us. It also includes all of us and the people we interact with. *The environment is everything around us.*

The Purpose of Environmental Education

The purpose of Environmental Education is to teach people about their environment and its resources, and to explain why good management and conservation practices are necessary. Because the habitats, health, and happiness of Pacific Islanders are dependent upon the environment and its conservation, the more specific aims of environmental education should be to improve our understanding of:

- **what** types of environments and reources exist in the Pacific Islands,
- **what** conservation means,
- **why** conservation and management of the environment and its resources is important, and
- **how** we can encourage conservation, protection of the environment and management of our limited island resources on a sustainable basis. Sustainable means that we use our resources carefully so that future generations of Pacific people will still have enough to provide for their basic needs of food, water, fuel, shelter and clothing, and so that as economic development of our islands increases, we will still maintain the important aspects of our island way of life.

Without proper management of the environment and careful conservation, there will be no future for the small, fragile environments and the peoples of the Pacific Islands. The development of these sound management practices and an understanding of the important role of conservation depends very much on appropriate environmental education.

Conservation and Development

Development means to improve or to make something better. But sometimes during the process of development, some resources are destroyed. That is why we need to ensure that development is undertaken carefully, and includes ***conservation*** of resources. Only then can development improve our lives.

People who attempt to make conservation part of development are called ***conservationists***. If all our children and adults were conservationists, then development would always make life better. Good conservationists must have a good understanding of their environment. Conservationists are helped to understand their environment by ecologists.

Ecologists are scientists who study the ways in which living organisms, including human beings, interact with each other and with their surroundings. They study these interactions and relationships between living and non-living things as part of an environmental system. Ecologists refer to the environmental systems where living things depend on each other and on the non -living parts of the environment, ***ecosystems***. Ecologists study ecosystems. The word "eco" comes from the Greek word meaning "home". So ecologists really study the "home" systems or environment of living things. Some ecosystems are small and some are big. A house, a pig pen, or a fish pond are ecosystems. The Planet Earth is an ecosystem.

All our Pacific Islands, our reefs and lagoons, our forests, our garden areas and our cities are ecosystems or environments which can be studied by ecologists. For example, an ecologist studying the tropical rainforest will try to understand all types of life there (the trees and other plants; all the different forms of animal life from amoeba and insects to birds and wild pigs; the light, soil, water and heat of that environment as well as the impact that the people living there have on the forest). We depend on the environment but often in our use of it we can have a ***negative impact***.

In the Pacific Islands, it is particularly important for an ecologist to understand the valuable uses that people have for their ecosystems, particularly their land, sea and forests. For thousands of years the land, forests and the sea have been sources of timber, food, medicines, dyes, fish poisons, perfumes, oils, fibre and rope, and many other things of ecological, economic and spiritual importance. With the help of ecologists and conservationists, we can predict the effects that the activities of human beings and their development projects will have on the environment; e. g., what the effects of logging for the export of timber or tree felling for agricultural development will have on the soil, water resources, the plant and animal life, and the climate.

Conservation and the training of conservationists are not activities which are opposed to development and change. Rather, they are activities which work together with development to make sure that there will be enough resources and a healthy environment for use by future generations. A good ***developer*** must also be a good ***conservationist***. He must try to fully understand the costs of development, including both the ***benefits*** that may be obtained by using the environment and its resources, and the possible ***negative*** effects that development may have on the natural and cultural environment. The negative costs must be minimised if our environments and cultures are to survive.

Conservationists want development that works with nature. Francis Bacon (1561 - 1626) expressed this point of view very well a long time ago when he wrote: "Nature, to be commanded, must be obeyed". This same basic understanding of the important relationship between respect for nature and the benefits that nature and our environment can give us is found in the traditional knowledge of all Pacific peoples. In other words, without a respect and understanding of nature and our environment, there can be no conservation. Without conservation there can be no sustainable development which will benefit ***future generations*** of Pacific Islanders.

The Importance of Conservation and Good Environmental Management

There are a number of reasons why conservation of nature and our environment is important. They include economic, social or cultural, ethical, aesthetic and scientific reasons:

Economic Economics can be defined as the study of the different ways people and their societies choose to use scarce resources to produce and to distribute the many things that people need or want. From an economic point of view, we need our air, water, soil, plants, animals and our traditional understanding of the environment to continue to provide money, food and other necessities. Agriculture and the collection of food from the sea depends on a healthy environment in which the laws of ecology are respected. The land and sea resources of our islands must be observed (not over-exploited) so that our children, our children's children, and the generations to come can produce and distribute the things they need for a good life.

Social or Cultural From a social or cultural point of view, the mountains, lagoons, water, caves, plants, animals, agricultural systems, settlements and other resources that Pacific peoples have developed and conserved over thousands of years, provide the basis for our culture - the island way of life - which we value so much. A failure to conserve these resources will undermine our culture.

Ethical Ethics is the study of what is morally right in the society. From an ethical point of view, it is morally correct to respect the natural environment and wrong to think that its resources are there only for humans to exploit and possibly destroy. Conservationists want to leave a living, productive natural world for others to enjoy. Pacific peoples are aware of the economic and cultural importance of plants, animals and other natural features. In many ways Pacific people have traditionally protected their environment and its valuable resources. Traditionally many conservationists knew that it was ethically and morally right to protect the environment and conserve resources for the future.

Aesthetic Aesthetics is the study of whether things are beautiful. From an aesthetic point of view, our idea of beauty is based on what we see in nature. If we destroy or spoil it, then the result is ugliness. A clear, fast- flowing river is more beautiful than a polluted, smelly, muddy river.

Scientific From a scientific point of view, we must understand that many types of plants and animals in the Pacific Islands are found nowhere else in the world and have not yet been recorded or studied to understand their special roles in the environment, and their importance to Pacific societies. Many of our plants provide important medicines which could be used to cure some of the world's more dangerous diseases.

We may accept that these are good reasons to promote conservation, to become conservationists, or to teach people how to become conservationists, but, unfortunately many people do not wish to get involved. Some people ask: "Our leaders do not seem to be concerned about conservation. Why should we be concerned? Can't we leave these things to nature?" Unfortunately, we cannot - the human race is in a crisis situation because of the very rapid increase in population and the effects of modern technology. As we try to improve the "quality" of our lives, we are often threatening the "quality" of our environment to sustain us and provide a healthy place in which to live.

We are also often threatening existing systems of agriculture and resource use and traditional knowledge of the environment which have provided for, and guided, Pacific peoples over thousands of years. Although Pacific peoples were not perfect, and destruction of some resources and parts of the environment did occur before modern technology was introduced, most Pacific peoples of the past were better conservationists than we are today. Thus, one reason for promoting conservation is to preserve in some way the traditional ways in which Pacific peoples acted as conservationists to protect their natural and cultural resources for future generations.

Identifying Environmental Problems and Issues

For environmental education to promote conservation and the sustainable use of resources, we must first identify the important issues and problems which affect conservation in the Pacific Islands. There are several pressing environmental problems, all of which give cause for concern. They include:

- water and land pollution;
- nuclear pollution and waste dumping;
- domestic, industrial and solid waste disposal;
- deforestation and soil erosion;
- plant and animal extinction;
- depletion of marine resources;
- mining-induced destruction;
- deterioration of Pacific agricultural and food systems; and,
- loss of traditional environmental knowledge.

These problems are some of the ***most critical environmental issues*** facing our island countries and territories of the Pacific. If these issues are not stressed in environmental education for our students, our leaders and policy makers, and the community, then the resources which we are using today will not be available for use and development by our children.

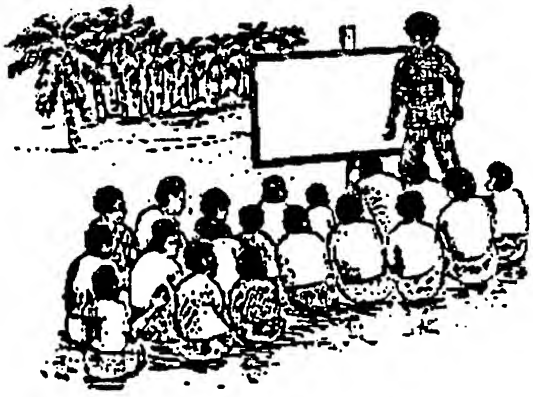
Educating People about their Environment

As we have already stated, there is a need for the use and management of limited natural resources and time-tested cultural resources in a ***sustainable*** manner. Human activities are leading to the destruction of the natural and cultural resouces which Pacific Islanders have depended upon for survival for thousands of years. Since resources are more limited on small islands, there is less room for error; Pacific islanders cannot just move on to a new "undeveloped frontier" as did the people who developed Europe, the United States of America, Japan, Australia and New Zealand. Some Pacific countries such as Wallis and Futuna, Nauru and some atolls are getting very close to their environmental limits. In some cases the rapid destruction of soil, deforestation and rapidly increasing populations are immediate threats to agricultural and marine resources. Soil and water pollution are also major problems in some countries.

In short, it is clear from the above list of environmental concerns that the Pacific Islands require unique forms of conservation and development, adapted to the limitations of their resource-poor island environment. What are needed are strategies that will manage the environments and natural and cultural resources for the benefit of future generations. These should draw on both traditional conservation strategies, as well as modern strategies, which will allow people to live within the limits of their island environments. Such development will have to be based on appropriate ***environmental education***, which attempts to make all students and future planners and policy makers into conservationists who understand important environmental issues, who will promote sustainable resource use and development and who will see conservation as integral to ***all*** Pacific Island development.

Unit One:

Teacher Training for Environmental Education



Emphasis and Approaches

This unit of the Manual offers suggestions for teacher training in environmental education, rather than describing a step-by-step course. However, it does provide useful guidelines for the undertaking of in-country Teacher Training Workshops, whilst recognising that each country's needs could be different. Certain factors that therefore need to be taken into account are:

- ❑ specific country needs;
- ❑ level of teachers' environmental awareness;
- ❑ level at which teachers teach;
- ❑ types of teaching methods used in classrooms;
- ❑ time available for training;
- ❑ accessable resources; and
- ❑ local curriculum opportunities for incorporating environmental concepts.

There is no intent, in preparing this material to suggest that environmental education should be taught as a separate subject. School curricula are already overcrowded. In most countries an infusion model is far more practical; the infusion philosophy aiming to maximise opportunities within existing curricula to convey environmental information and to develop attitudes of concern for the environment.

This approach can, however, run into difficulties in determining for each country who has, or who must share the responsibility for, organising teacher training for environmental education. After the initial series of SPREP/ICOD Teacher Training Workshops, other avenues for use of this Manual should be explored such as utilising the services of:

- ❑ specialists/advisers;
- ❑ travelling advisers (e.g. funded by SPREP, UNEP);
- ❑ teachers college staff (inservice and preservice);
- ❑ a senior teacher in a school for school-based inservice; and
- ❑ curriculum development officials.

Of course, interested teachers, youth workers, community workers and others could also find this Manual of value and appropriate to their needs.

Learning-by-doing

The emphasis throughout is on 'learning-by-doing'. Teachers, children, all of us, learn more through practical involvement than by passive listening and observing. Many of the teacher education activities in the Manual may also be appropriate for use in the teachers' classrooms. It will depend on the particular level of the classes and availability of resources. A second essential element is to provide opportunities for teachers to talk through, and hopefully solve, the problems they perceive in applying particular activities in their own classrooms.

The Teacher Training Workshop

Logistics

The optimal number of teachers / extension officers for training in one workshop is fifteen (15). They will need to be available for a period of five (5) working days. Resource people/trainers will need to meet two days beforehand to ensure they are well-versed in the proceedings planned and able to work as a team for the 5-day workshop. Three resource people/trainers should be sufficient, one of whom should be from the country in which the workshop is being held and preferably be the person initially involved in the development of the Manual at the 1988 Environmental Education Curriculum Workshop held in Suva. A range of material will need to be available such as posters, videos (plus player), slides (plus projector), scissors, selotape, large sheets of paper, markers, etc. Relevant resource material is available from SPREP and in some cases from organisations in the host country. A building large enough to enable the group to comfortably split into three (3) smaller working groups is the preferred venue.

Introductory Session

On the first day of the Workshop, after teachers and the trainers have been introduced, the purpose and need for environmental education and the anticipated outcomes of the training workshop should be outlined (See pages 7-11 in this Manual for details). For the benefit of the trainers, and to facilitate good communication, name tags should be made available.

Scene Setting Activities

The following four (4) activities are aimed to set the scene for the ensuing days of the workshop.

Activity 1

- ❑ Divide the teachers into three (3) groups of five (5) people and ask each group to list down the environmental problems in the Pacific region and/or their country. It may help to give one or two examples to illustrate what you mean e.g. soil erosion, toxic waste disposal.

- ❑ When the lists are complete, have the groups reassemble and show slides and/or videos, e.g. Problems in the Pacific Islands Environment (available from SPREP). Whilst watching, the teachers should check their list against those problems appearing. Any that they did not include should be added. (This activity can be made more competitive if that is part of the accepted culture).

- ❑ Discuss the problems, allowing all teachers to express their views. This could include a prioritisation of their country's environmental concerns.

Activity 2

- ❑ Using a poster on the environment, e.g. SPREP'S Coastal Environment Poster, ask the teachers to analyse the message being conveyed. (This could be done with all the teachers in small groups working on one poster, or with each group working on a separate poster).

- ❑ The teachers should discuss:

  (a) how the message may be more readily conveyed; and

  (b) how this teaching aid might be used in classroom activities to introduce environmental topics.

- ❑ Each group should report back to the others. Additional suggestions and discussion should be encouraged. This will help to develop a resource base, and encourage the exchange of ideas.

Activity 3

- ❑ Organise a field trip (bus trip/walk). The route should be organised to encounter a range of environmental problems, e.g. litter, deforestation, effluent discharged into the water (stream, river or sea), domestic waste, vehicle exhausts.

- ❑ The teachers should note down the environmental problems that they observe.

- ❑ If possible stop at a couple of sites and examine the issue, its origin, its effects and possible solutions. This should raise many points of discussion. (If there are constraints of time, it could be possible for the teachers to observe environmental problems on their journey to the workshop and then compare notes and discuss).

Activity 4

(Only appropriate in larger countries with newspaper reporting of environmental problems).

- ❑ Divide the teachers into small groups each with:

  (a) a large sheet of paper,
  (b) scissors,
  (c) markers, and
  (d) back copies of newspapers and magazines.

- ❑ Ask them to prepare a collage of newspaper articles which mention environmental problems. Encourage them to make up headings for other environmental problems they know about and add these to the collage.

- ❑ Display their work as a reminder, throughout the workshop, of environmental concerns.

> In all of the above cases it would be valuable to involve an additional local resource person (e.g. from a local environment group) to give other dimensions and a clearer definition to the pertinent environmental issues. This will add extra knowledge, give a broader base for interaction and discussion, and encourage greater co-ordination of environmental education initiatives to continue after the Workshop.

Discussing the Nature and Aims of Environmental Education

To be undertaken when teachers have reassembled in the large group session.

After illustrating, in the Introductory Session, the need for environmental education, and after having set the scene for further discussion through the above four activities, it is appropriate to discuss now the underlying philosophy and nature of environmental education before proceeding to consider the approaches possible in school. It would be best to first consider, at a general level, the nature of environmental education and then, after adequate discussion, to frame more defined aims. At this stage of the Workshop, there should now be a clearer conception of the environmental issues, and it is appropriate to open the question of the ***nature of education about the environment*** to the teachers.

There are two immediate organisational possibilities:

Brainstorm: Collect ideas from the teachers without comment. Write these up so that they are clearly visible to all the participants i.e. on chalkboard or blank newsprint. This can then be followed by a discussion of each idea and perhaps collation of them into more easily conceptualised groupings.

Small group discussion: Each group discusses education on the environment and produces a list. These can then be reported back to the whole group and collated.

Some characteristics of environmental education are listed below. You may need to supplement the teachers' ideas or vice versa. Environmental education is a process of active inquiry which can have the following characteristics, namely it:

- ❑ is part of a life-long process;
- ❑ crosses the boundaries and synthesises the viewpoints of a number of traditional academic areas;
- ❑ makes use of the school environment together with its social and physical surroundings, as educational resources;
- ❑ involves a wide range of experiences beyond the classroom;
- ❑ is centred on realistic situations, from issues of local, through national, to global, significance;
- ❑ emphasises the interactions among human systems, natural systems and resources;
- ❑ encourages recognition of the need for a more equitable distribution of the world's resources;
- ❑ involves preparing students for active participation in the shaping of their world, which is always changing;
- ❑ develops a commitment to continued participation in the resolution of problems of the total environment; and
- ❑ creates new patterns of behaviour towards the environment in individuals, groups, and society as a whole.

In addition, reference should be made to the early pages in this Manual.

Next, we need to consider ***the aims of environmental education***. This is important as it relates the general nature of environmental education to the formal (or non-formal) education system. It also lays the bases from which the development of useful environmental activities will emerge. A similar organisational pattern could be used as was done earlier, i.e. brainstorming or small group discussion and reporting back.

The following list of aims was prepared in New Zealand and could be adapted or adopted for other countries.

The aims of environmental education are to help students:

- ❑ develop an **awareness** of, and **sensitivity** to, the total environment;
- ❑ develop a **basic understanding** of the total environment, particularly the interrelationship of people and their environment;
- ❑ develop practical, personal, social and valuing **skills** necessary for investigating the total environment and resolving environmental issues;
- ❑ clarify their **values** and develop a **personal code of behaviour** towards, and a life-long concern for, the environment;
- ❑ make **informed decisions** about the environment by considering alternatives based on ecological, political, economic, social, aesthetic and other relevant factors;
- ❑ become **motivated for active participation** in environmental management, including both protection and improvement;
- ❑ create and respond to **opportunities** to be actively involved in working towards the resolution of environmental issues.

Learning and Teaching Strategies

This part of the Manual and this stage of the Teacher Training Workshop aims to develop and broaden the range of learning/teaching activities possible in schools. In other Units of this Manual, there are specific classroom activities for learning about the Marine Environment, Pollution, Agricultural Practices and Traditional Environmental Knowledge. In this particular Unit (No. 1), the overall strategy for incorporating environmental content generally into classroom activities, is outlined.

There will always be the problems of resources, accepted teaching approaches, a teacher's personal style, school atmosphere or ethics and teacher confidence. All of these affect the range and choice of learning/teaching activities for a particular teacher.

Prior to any other considerations it is important to stress the **activity-based nature of environmental education.** Inevitably this moves away from casting students in a passive role and promotes active learning. It must be added too, that frequent changes of approach to learning/teaching also have the effect of creating greater interest and enlivening the students' learning experiences.

Workshop Activities

Brainstorm with the teachers in the large group on "What learning/teaching activities can be used in schools?" The list of possibilities may include:

Chalk and talk	Drawing	Field trips
Group work	Experiment	Drama
Class discussion	Invited Speakers	Research
Demonstration	Role play	Investigation
Games		

Discuss the possibilities and constraints of each of these. (Often difficulties in adopting a particular learning / teaching strategy relate to the teachers' perception of their own roles). Select or explore some of the activities using concrete examples involving environmental concepts and reference to relevant subject areas.

The possible training approaches for the remainder of this section of the Manual include:

(a) a consideration by the whole group of each activity example, then suggestion of curriculum areas or lesson for which the activity is suitable;

(b) groups of teachers working on one activity, exploring its potential and developing some examples for use in schools, followed by feedback and exchange; and

(c) teachers taking the role of students and experiencing learning through that particular activity, followed by feedback and discussion.

Workshop patricipants should, by one of these three approaches, undertake the following teaching \ learning activities:

Activity 1: Investigating Simple Environmental Problems.

Activity 2: Drama and Role Playing

Activity 3: Field Trips

Activity 4: Drawing from Real Life

Activity 5: Process Drawing

Activity 6: Games and Outdoor Activities

Activity 1: Investigating Simple Environmental Problems.

One aim of environmental education is to help students develop the thinking skills that can be used to find solutions to environmental problems. Problems chosen for classroom study have to be sufficiently simple for students to grasp the nature of the problem, and then to think of possible solutions. Ideally, there should be scope for the students to make a positive contribution to the solution of the problem, even on a small personal scale. In some cultures, however, it may not be acceptable for young people to suggest things for adults to do.

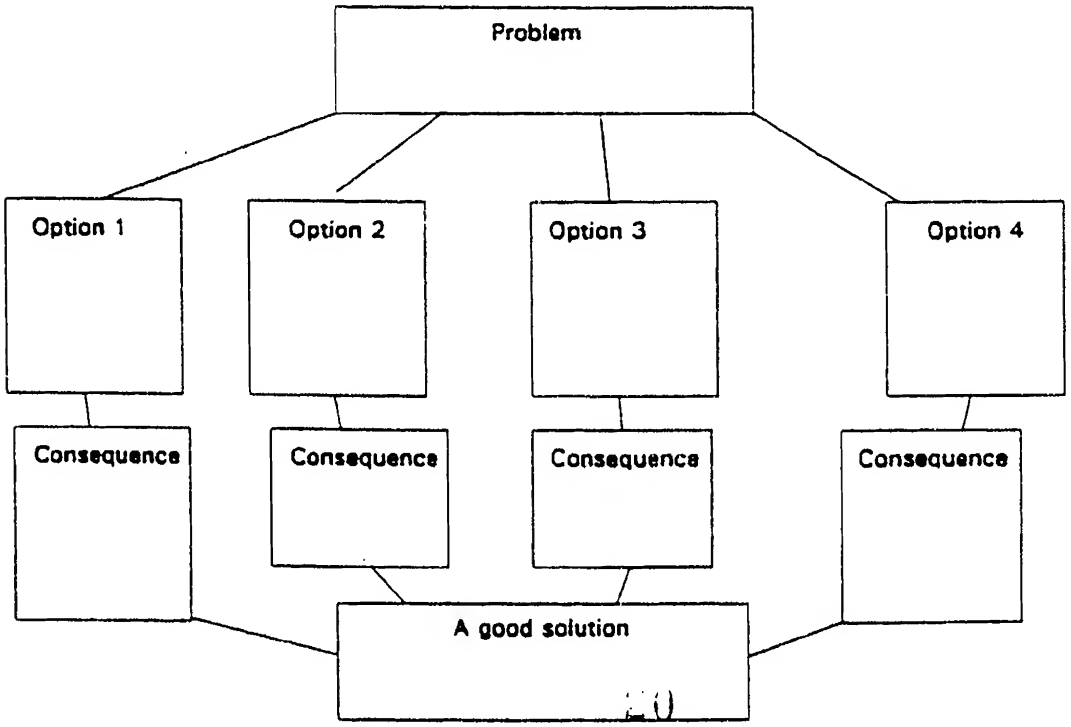
The Trainer suggests that the teacher investigate the problem of litter in the playground, or how the school grounds could be made more attractive. Allow plenty of time for discussion at the end of the activity, as teachers may see problems in using this type of activity in their community. Set up small groups and ask group members to discuss the "problem", then write down answers to these questions:

- ❑ Why does it exist?
- ❑ Who, or what, causes it?
- ❑ When does it occur?
- ❑ What do different groups of people think about it?

Help the teachers to find sensible solutions to the problem by asking them to discuss these questions:

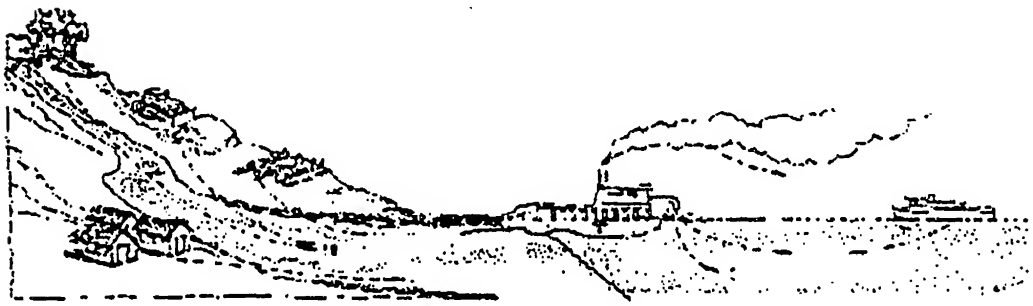
- ❑ Which people can help solve the problem?
- ❑ How have people in other places solved this problem?
- ❑ What solutions can you think of?
- ❑ What consequences would these have?
- ❑ What do you think is the best answer? Why?

Summarise the final steps on a wall chart as shown in the example below.



Help participants decide on any further action that students may wish to take (optional). (Children who have become concerned about a problem can be left feeling frustrated and powerless if they are not able to do something about it. Any further action should be within children's capabilities and may need to be discussed with the school principal.) Possible actions include:

- writing letters to local newspapers or the appropriate authority,
- preparing displays to influence other people, and
- initiating projects e.g. landscaping or clean-ups.



Activity 2: Drama and Role Playing

Drama and role playing as teaching methods could be taught under various curriculum headings, especially Language. Writing, speaking and listening are all components of a Language curriculum and could be used effectively in producing drama based on legends or the history of the island. (This activity would be for junior high or high school students. It may take too long for the Trainer to go through it with the Trainees, but it could be described and then given to the teachers as an activity they may wish to try).

(a) Drama

- With a class divided into groups, one group could listen to and record stories and legends told to them by elders in the village. Another group could research the traditional songs and dances that might pertain to the environment (harvest dances or songs). Another group could research the impact of outside influence on their island (British, American, French, German, Spanish, Japanese) as to changes in language, foods, songs and dances, dress, economy, values, education, traditional ways of life, and uses of the land and sea.

- This knowledge collected could then be put into a drama depicting 'The History of Our Island'. How the drama is put together would be up to the students' or teachers' creative abilities. Built into the drama should be feelings as to whether these changes are good or bad.

- Drama can also be used with very young children, where the children assume the roles of plants, animals or other people. More guidance would obviously be needed here than with older children.

The teacher could state the environmental concept to be portrayed and the students could give the setting and character needed. This could be done in small groups or in a class as a whole. Ideas could be suggested by the children and they could write the dialogue. This drama could come as a culmination of an environmental study visit and could be presented to parents, other classes or may be videotaped. An example of such a drama follows.

Environmental concepts to be woven into the drama:

- ❑ *Air carries odours or smells. We need to breathe clean air.*
- ❑ *Gardens and farms are necessary in producing our food.*
- ❑ *Plants need soil, water and sunshine to grow.*
- ❑ *We must take pride in our island and must be concerned about conserving its beauty and resources.*

Characters:

- ❑ *Two school children*
- ❑ *Grandmother and grandfather*
- ❑ *Plants and animals*
- ❑ *Children's cousins*

Settings:

- ❑ *Roadside*
- ❑ *Home*
- ❑ *Island or children's neighbourhood*

An example of a possible drama to be produced by the students:

Two children are walking home from school and they smell a dead dog lying beside the road. They carry on a conversation about the smelly dog (children write their own dialogue). When they get closer to home they smell chocolate chip cookies (or some appropriate food of the island) baking, and upon arriving home they tell their Grandmother, who then discusses with them the property of air carrying smells, and the importance of breathing clean air. (Again the children write the dialogue.)

They are interrupted by Grandfather calling to the children to go with him to the garden to work and to feed the pigs. Children complain about having to work when they would rather play, at which point Grandfather explains to them the importance of the garden and animals as food sources for the family. They go on to work in the garden and as they are working Grandfather explains to them that plants need air, water, soil and sun in order to grow. Different kinds of soil could be talked about here.

Upon returning home from the garden the children find out that their cousins from ..... have come for a visit, and the children proceed to show them all around their island playing in the waterfalls and rivers, climbing the mountains or hills, swimming in the ocean, walking through the forests, smelling the flowers, listening to the birds etc. (The children can be the flowers, birds and animals as needed).

Before the cousins leave they say how much they have enjoyed their visit, and that they hope . e island will stay just like it is forever and ever so they can come back again and have fun in such a beautiful place. (Again the children can write the dialogue and ending.)

(b) Role Play

Role Playing can be another effective method by which environmental concepts and issues can be taught. The trainer will state an issue (could be one which the teacher had said was important to his/her particular island) and several teachers could take the roles of interested parties and role play their interests. An example might be:

Environmental issue: *Pollution on the beaches*

Participants in role play:

- ❑ *Tourist*
- ❑ *Local resident having a picnic at the beach*
- ❑ *Environmental Protection Agency official or a Government Conservation Officer.*

Role play:

Each participant will talk about the issue from their point of view. This could be worked into a drama as well, depending on how the teacher decides to do it.

Activity 3: Field Trips

There may be many reasons why teachers may be reluctant to take their class outdoors. One is a feeling that they lack scientific knowledge. ("I'm not a science teacher"). Another is a question of whether or not the teacher will lose control of the children out of doors and, as well, there may be cultural reasons for not taking classes out of the classroom.

To answer the first concern, the primary teacher needs to realise that he/she doesn't need to be a science teacher. Resource books can help here, as well as training experiences. The teacher needs to accept that he/she can say, "I don't know", without losing face. The teacher also needs to learn 'Tricks of the Trade' as it were, to develop field trip confidence. If the teacher goes through the experience at the Workshop and sees it work, as well as understands its value, he/she is more likely to try it.

One of the best ways for children to learn about their environment is to get out into it. In order to get the most from the experience it has to (1) be organised and (2) contain a learning aspect. If children understand beforehand that the field trip is really 'School Without Walls' then it should be more than a play activity. This does not mean it can't be fun. The organisation of the field trip is up to the teacher, who has to decide an activity appropriate for the age and learning level of the children.

Other pre-trip considerations are:

1. Is the field trip in the school yard or nearby?
2. Does the field trip involve walking on roads with vehicular traffic?
3. Is transportation needed?
4. Will the children need parental permission? Principal or head teacher permission?
5. Will the children carry lunch? water? collecting equipment? note taking materials?
6. Will the field trip be in an area where the children will get wet? Will hats for shade be needed?
7. Will a parent or two be asked to help?
8. Do the children understand **beforehand** why they are going on a field trip?
9. Will it work better to have the children in small groups, each with tasks to do?
10. How far away from the teacher are the children to be allowed to go?

The above might be referred to as **10 Rules for a Field Trip.**

Most important: The teacher should also plan a post field trip activity back in the classroom which can serve as an evaluation exercise.

Considerations are:

1. What do student recorders do with their notes or data?

2. Are there organisms collected on the field trip which need immediate attention back in the classroom? (e.g. marine life)

3. What post field trip activities will be done on field trip day, next day or during the week?

4. Are there related activities that can be carried on by the teacher in other curriculum areas?

Example of a Post Field Trip Activity:

Plant Collection

1. Put all the leaves together and decide how to categorise them: by shape, by size, by texture, by color, by plant species, or all of these. How many leaves are there?

2. Make a bulletin board display of the leaves. Paste or staple the leaves on pieces of paper. (This is not long-lasting but can be very effective).

3. Let each child make a drawing of his/her leaf.

4. The teacher can tell the children or find out from the children the names of the plant each leaf comes from.

5. Decide if the plant each leaf comes from has a use. For example, for medicine, food, animal food, perfume, decoration, photosynthesis - and write about this use.

6. If paint is available make leaf prints, or spatter prints (art).

7. Trace the leaf shapes.

8. Press the leaves between paper (a paper towel is best) and weigh this down with heavy books or tie them together. Let them dry for several days.

In the Workshop, using one particular proposed field trip, go through the considerations with the teachers. Look at the details of pre, during and post field trip activities of both the teacher and the children. Discussion of potential problems in the organisation and conducting of a field trip is important. A role play may be a more convincing portrayal of these potential problems and methods with which teachers could deal as they arise.

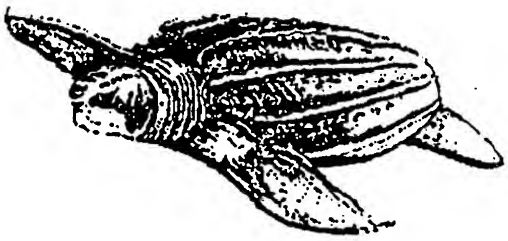
Activity 4: Drawing from Real Life

Children's awareness of some aspects of their environment can be developed through two different types of drawing activity.

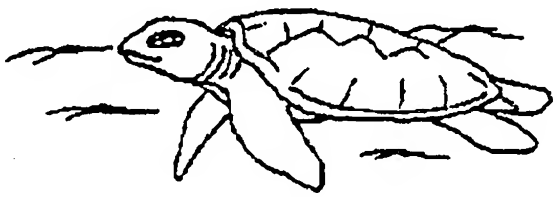
(i) **Observational drawings / biosketching** which stress accuracy and often have component parts labelled; and

(ii) **Artistic impressions / personal expressions** which convey an individual's impression of a subject and may incorporate an emotional response. Texture, shading, colour and form are all important and may not be meant to be true to life.

e.g. a turtle



Observational drawing / biosketching



Artistic impression / personal expression

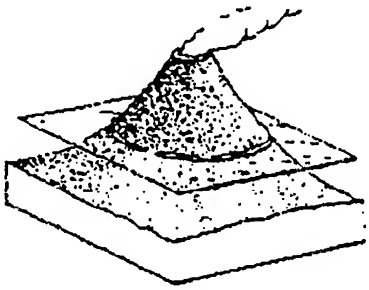
(Both have value educationally. Children's artistic work often improves as they develop their observational skills.)

At the Workshop, ask the teachers to produce an observational drawing and an artistic impression of the same item. You can specify the item or leave the choice up to individuals, but it is a good idea to tell them how long they have to complete the task. They can work inside or outside, but should work from the real thing, not from memory. Many teachers are embarrassed by what they regard as their own low drawing ability, often stating "I can't draw". So suggest they choose something simple e.g. a leaf or a rubbish bin. Trainers familiar with the 'process drawing' approach may find that technique helps overcome teachers' reluctance to put pencil to paper.

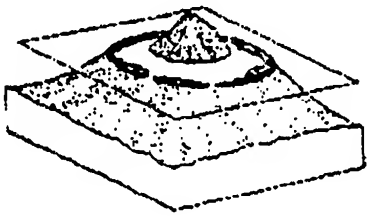
Activity 5: Process Drawing

There are obvious parallels between reading and writing and interpreting illustrations and drawing. In recent years teachers have come to recognise that writing is a process in which the writer develops and refines his ideas in stages over a period of time. The same is true of drawing. Drawing can be a form of problem-solving - observing what is present, deciding what to include in the drawing and how it should be presented. Talking over a first draft with another person is a useful way of beginning to improve a drawing. After several revisions most children begin to feel more comfortable with what they have drawn and in this process have begun to observe more carefully and critically. Process drawing can be a useful approach to describing the environment, particularly where relationships are important.

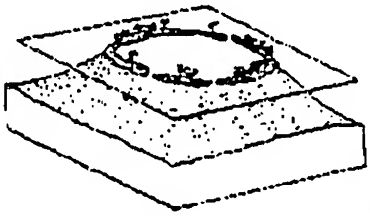
Fringing reefs grow at the edges of continents and islands. The reef front contains actively growing corals, and pieces of broken coral are washed up as rubble on the reef flat.



Barrier reefs are separated from the shore line by a lagoon which is often deep. Corals grow in the calm waters of the lagoon as well as on the reef front.



Atolls are coral reefs growing in the shape of a circle. The reef, which often has small islets on it, surrounds a lagoon.



Process drawing showing the development of a small tropical island over time.

To show the teachers the potential for this activity and the standard that can be achieved by the children, display examples of childrens' drawings previously done.

Conclude the session by helping teachers to compile lists of situations in local curricula where each kind of drawing can be used to increase environmental awareness.

Activity 6: Games and Outdoor Activities

Games and outdoor activities offer another excellent method of teaching environmental concepts, skills, and decision-making about the environment. The following games offer a wide range of activities that could be used outdoors or in most cases could also be adapted for indoors. The board games are fun to play and also fun to make. These games can be used as part of a lesson e.g. the introduction, reinforcement activities or as extra-curricula activities. At the Workshop, the teachers should 'play' these games themselves to determine their applicability to the classroom situation.

Game A: Population Changes

(Adapted from Outdoor Biology Instructional Strategies)

Important:

Explain to the children before going out of doors, how to play this game and its objective.

Material:

- ❑ Bags/cups/envelopes
- ❑ Wall chart
- ❑ Buttons/bottle tops/beans

Objective:

The object of the game is to show how a population of an organism varies from year to year and how the food source will determine the yearly carrying capacity'. On a piece of paper put the following chart. Any animal can be used. We have used Parrot fish.

Population of Parrot Fish

	Beginning	End
Year 1		
Year 2		
Year 3		
Year 4		
Year 5		

Procedure:

Take out some plastic bags or cups or envelopes for each child to represent the 'Parrot fish stomach'. The children could use their pockets instead. For each child you will need 10 pieces of one kind of item (beans, coloured cloth, soda bottle caps, buttons, etc.) to represent the food (coral). All the 'food' (coral) will be set out in the main playing area. You will also need another group of six items for each student. These will be spread out for 'food' (coral) in another area away from the first.

The children will be given one 'stomach' (envelope/cup/bag) and 'one year' (one minute) to 'eat' (collect) enough food from the playing area to survive (no less than five, no more than ten pieces). If they survive they 'reproduce' (i.e. they are given another 'stomach') to feed for the next year.

Carry this out for at least three to four years (3 to 4 minutes) to show how the population tends to stabilise. Remember to fill out the chart at the end of each year (minute). At the end of each year, have the class come back together to put down the number of Parrot fish that survived and how many you will have for the start. You should have twice the number at the beginning of each year as you had at the end of the previous year.

At the beginning of the fourth year, tell the children that there was a large road-building project and heavy rains this past year which washed a lot of silt down onto the reef. The food (coral) has died because of the siltation so there is less food. Remove about half to three-quarters of the food pieces before the Parrot fish go out this time.

At the end of the fourth year, discuss with the children what they would do if they were short of food. Many animals would either die or leave the area to find food elsewhere. So, on year five, go to the other area where you have set out other 'food'. Complete this last year then return to the classroom. Now, have the children sit down and discuss the chart, asking the following questions:

- ❑ What things does the chart show us?
- ❑ What year was our population largest?
- ❑ What year was our population smallest?
- ❑ What year had the biggest change? Why?
- ❑ What seems to be the 'carrying capacity' of the starting area and food source?

Game B: The Food Web Game

This activity can be done indoors, with the children either remaining in their seats or outdoors.

Material:

- ❑ A sign with a local animal or plant name for each student (they might pick what they want to be and make the sign themselves.
- ❑ A ball or skein of wool (yarn) or string.

Procedure:

- ❑ Students each represent a different animal or plant. They may select these but make sure you have a wide variety of producers (plants and animals) that both eat plants (herbivores) and animals that eat other animals (carnivores), or eat both (omnivores). Don't forget humans.

- ❑ The teacher or one child is the web maker. Start the string at one plant and ask who or what animals eat that plant. The web maker then stretches a string between the plant and the animals that eat it. Make all the consumer/producer connections you can. Continue this process until all the plants or animals are connected together with the string forming a food web.

Now discuss with the children what they have observed:

- ❑ What does the string represent? (Something being eaten)
- ❑ How are all the animals interconnected in the web?
- ❑ What would happen if one of the plants was killed off or removed?
- ❑ What would happen if we had too many of one kind of animal? What other animals or plants would suffer?

Game C: Make your own Environmental Board Game

Materials:

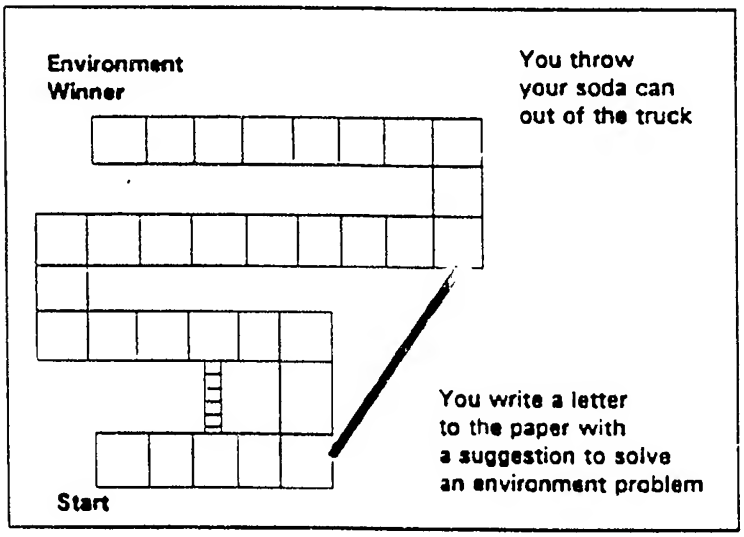
- ❑ large sheet of paper or cardboard
- ❑ pen and coloured pencils
- ❑ extra piece of cardboard (small) and drawing pin (if making a spinner card when dice is not available).

Procedure:

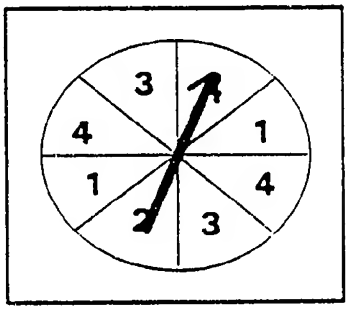
As a class activity, have the children make a game of Snakes and Ladders using environmental actions that are good to go up the ladder, and environmental actions that are bad to go down the snake. Remember the class will need a dice or a spinner card. (Perhaps they can make their own spinner! See example below).

The teacher should draw up the basic outline of the game beforehand and have the children suggest the 'good' and 'bad' environmental actions, and their placement on the game.

Once made, this game (and others) can be re-used on other occasions especially as a reward for the class.



Environment Snakes and Ladders



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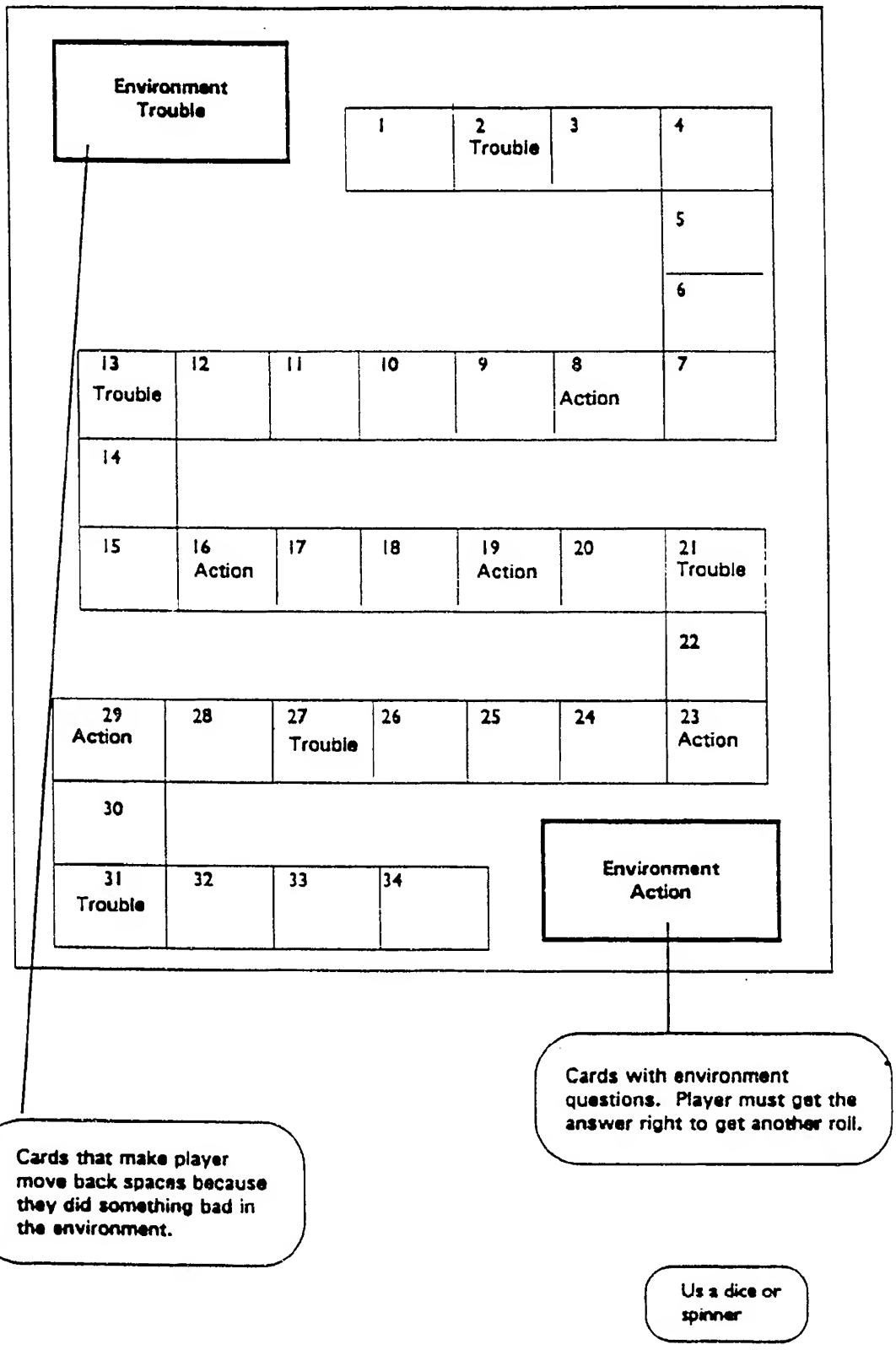


Alternative Environment Dice Game

Game D: **Habitat Lap Sit**

Materials: None required

Objectives:

To enable the children to:

- ❑ identify the components of habitats;
- ❑ recognise how humans and other animals depend upon their habitat; and
- ❑ interpret the significance of loss or change in habitat in terms of people and wildlife.

The major purpose of this activity is to assist the class to become familiar with the components of habitat, and to recognise that it is not sufficient for there to be food, water, shelter, and space in order for animals to survive - but that these components of habitat must be in a suitable **arrangement.**

Procedure:

The teacher should explain to the children that people and other animals share some basic needs. Every animal needs a place in which to live. The environment in which an animal lives is called its 'habitat'. An animal's habitat includes **food, water, shelter,** and **adequate space,** in an arrangement appropriate to the animal's needs.

If any of these components of habitat are missing or are affected significantly so that the arrangement for the individual animal or population of animals is no longer suitable, there will be an **impact.** The impact will not necessarily be catastrophic, but could be. There are a great many additional limiting factors beyond those of suitable food, water, shelter, and space which need to be explained to the children. For example, disease, predation, pollution, accidents, and climatic conditions are among other factors which could have impact.

The teacher should explain to the children that all things are interrelated and that when we look at a biological community, we find **interrelationships** and **interdependencies** between plants and plants, plants and animals, as well as animals and animals. These interrelationships and interdependencies are very important.

After explaining this information to the class, the activity itself actually takes very little time - but has a lot of impact! Ask the children to number off from 'one' to 'four'. All the 'ones' go to one corner of the room, the 'twos' to another, etc.

As the children move to the corners, clear a space in the centre of the room. (Better still, go outside to a clear, grassy area). The 'ones' should sit or stand together, 'twos' together, etc. Assign each group a concept as follows: 'ones' = food, 'twos' = water, 'threes' = shelter, 'fours' = space.

Now, it is time to form a circle! Do this by building the circle in chains of food, water, shelter, and space. One person from each groups walk toward the cleared area. The four children stand next to each other, facing in toward what will be the centre of the circle. Four more children - one from each group - join the circle. Keep adding to the circle in sets of four until all the children are in the circle.

All children should now be standing shoulder to shoulder, facing the centre of the circle. Ask them to turn toward their **right**, at the same time taking one step toward the centre of the circle. They should be standing close together, with each child looking at the back of the head of the one in front of him or her.

Don't panic - this will work! Ask everyone to listen carefully. Everyone should place their hands on the waist of the person in front of them. At the count of three, you want the children to sit down...on the knees of the person behind them, keeping their own knees together to support the person in front of them. You then say, "**Food, water, shelter, and space - in the proper arrangement** (represented by the children's intact, `lap-sit' circle) - are what is needed to have a suitable (good) habitat."

The children at this point may either fall or sit down. When their laughter has subsided, talk with them about the necessary components of suitable habitats for people and wildlife.

After the children understand the major point - that food, water, shelter, and space are necessary for any animal's survival, and in their appropriate arrangement comprise a suitable **habitat** - let them try the circle activity again! This time ask them to hold their lap-sit posture. As the children lap-sit - still representing food, water, shelter, and space in their appropriate arrangement - identify a child who represents `water', then say, "It is a drought year. The water supply is reduced by the drought conditions." At this point, have the child who identified as representing `water' remove himself or herself from the lap-sit circle - and watch the circle collapse, or at least suffer some disruption in arrangement. You could try this in several ways - removing one or more children from the circle. Conditions could vary: pollution of water supply, urban sprawl limiting availability of space, soil erosion impacting food and water supplies, etc. Since animals' habitat needs depend upon food, water, shelter, and space, in their appropriate arrangement, `removal' of any one will have an impact.

Ask the children to talk about what this activity means to them. Ask them to summarise the main ideas they have learned. They could include:

(a) food, water, shelter, and space, in their appropriate arrangement, can be called habitat;

(b) humans and other animals depend upon habitat;

(c) loss of any of these elements of habitat will have impact on the animals living there; and

(d) the components of habitat must be in an arrangement suitable to the needs of the individual animals or populations of animals in order for the animals to survive.

Variation to this Game:

Have the children form a circle, holding hands. Walk around the circle, first naming one as an animal of a particular ecosystem. Name the next four children in the circle as food, water, shelter, and space for that animal. Repeat the process until all children are involved. Any `extras' can be identified as elements of habitat, e.g. resulting from a particularly good year for habitat needs for the last animal named. When all the children have been designated as an animal or as components of an animal's habitat, comment on the fact that they are holding hands. This represents the idea that all things in an ecosystem are interrelated. Briefly discuss the idea of interrelationships. Then move the children into position to do the `lap-sit' described in the procedure above. Remind them that they noticed all elements of the ecosystem were interrelated when they were holding hands. Now they are going to find out that they all are dependent upon one another as well. Do the `lap-sit'. Discuss interrelationships and interdependencies in ecological systems.

Comprehension Questions:

- ❑ What are the five essential components of habitat?
- ❑ Explain how the arrangement of food, water, shelter, and space is important to humans and other animals.
- ❑ What would probably have the greater long-term impact on the wildlife living on a farm? A severe drought/flood/cyclone which killed many animals, or the development of part of the farm into a commercial shopping centre?

> There are many other games that can be developed with an environmental message, such as charades, bingo, a quiz, word searches, crosswords, and anagrams. As the teacher becomes more confident with incorporating environmental content into lessons, these ideas can be developed.

Integrating Environmental Education Activities and Ideas into Existing Curricula

In this section some models for integrating environmental education into other subject areas are proposed. Obviously these are limited and all may not be appropriate to demonstrate in the short time available at a teacher training workshop. Again this will depend on the teachers involved, the level at which they teach, and the nature of the existing curriculum. It is hoped, however, that the models included will illustrate the possibilities for integration and provide guidelines for development of further environmental activities.

The particular examples in this Unit are:

A. Environmental Education and Maths.
B. Environmental Education and Language.
C. Environmental Education and Art/Music.
D. Environmental Education and Social Studies.
E. Integrating Environmental Education.
F. Using Activities and Developing New Ones for Environmental Education.

Important: Use more ideas and specific activities from the other units in this Manual, namely:

Unit Two	-	Marine Environment
Unit Three	-	Pollution
Unit Four	-	Agriculture
Unit Five	-	Traditional Environmental Knowledge

A. The Environment and Maths

Maths is often regarded as a subject full of difficulties for the learners and thus for the teachers. The 'environment' can be used to make Maths more interesting whilst stressing aspects of environmental concern. It may help the children to relate to this subject more effectively, especially as the activity-based nature of environmental education can serve to enliven Maths classes.

In Maths, the scope for inclusion of environmental concepts is wide. For instance, activities could be undertaken in which young children count the trees in the playground, categorising them into sizes (taller - shorter, many branches - few branches), size of the leaves (long - short, wide - narrow) and in which older students measure the circumference of a tree, averaging how many leaves on a tree. Distances could be measured between trees using children's own feet, rulers, or a piece of string which, for older students, could lead into a discussion of density of forests and their relationship to survival.

Following are some examples which the teachers at the Workshop could undertake to determine applicability to their classroom setting.

Addition

Children learning how to add could help mitigate a village problem where people are not observing a law to pen pigs. The teacher takes the class for a village walk and they count the number of loose pigs. They then put up a poster on the village bulletin board saying: "On Monday there were 28 pigs loose in our village". This exercise is repeated on the following day, with the children being encouraged to do the counting as homework. (This lesson has an awareness aspect, a skill practice and an action input and it could help to solve a real problem).

Multiplication

Children usually learn multiplication by rote and there is a practical aspect to this in the beginning. But practising the skill could involve environmental awareness using census or survey techniques. For example, the teacher has the children cut string to make a thirty centimetre square. In groups outside children place the string squares on the ground where there are ants and leaves present and count the number of ants in each square. Back in the classroom the children add up the population of ants in each square and multiply by the number of squares to find a total. This is mainly a skill lesson which has value for survey techniques later on.

Division

For division skill practice. the teacher could pose a problem of: "How many leaves on a certain species of tree?" The problem could be solved fairly quickly by using the Maths skills of addition, multiplication and division. The children could be divided into small groups and asked to go to several trees of the same species. They count the number of leaves on 4 or 5 branches, then they count the number of branches on the tree. They add the number of leaves on the 4-5 branches and divide by 4 or 5 to get the average and then multiply that by the number of branches.

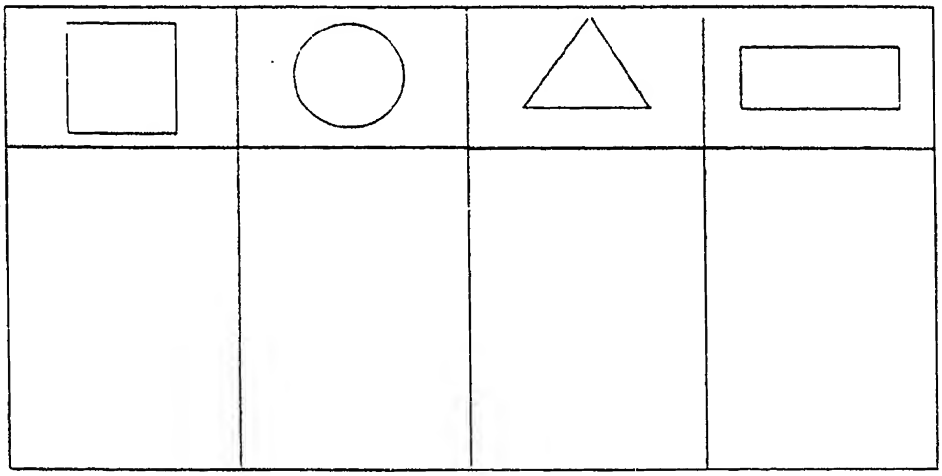
Each group's results could be compared to the other groups' work and graphed or recorded as data. This is a sampling survey technique similar to that used by pollsters trying to predict how many people will vote, or for census work on a certain population of birds or trees.

Graphs

Graphs can be started at an early age using pictorial form and instead of using only classroom examples, the children can actually count items in the village dump or solid waste area to find out which item is being thrown away the most, and thus obtain data for a graph.

Shapes

Using the four basic shapes that the very young children know; namely square, circle, triangle, and rectangle, the class could be taken outside to find these same shapes in nature. The teacher can make a very simple grid and ask the children to draw in or write what they see as having a specified shape.



Measurement

For children learning how to measure, practice of the skill can be transferred outside to measure things like tree widths. This could encompass awareness and understanding of tree growth as well as practising a Maths skill.

Using the formula:

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

the older students could measure the speed (rate) of flow of a stream or river. This can be simply done by placing two sticks, say twenty feet apart in the water and floating a coconut from one to the other, timing its progress. Other Maths skills could be included by sampling and averaging the data.

Symmetry in Nature

Many things in nature show symmetry. For example, many leaves show bilateral symmetry. Flowers and fruits often show symmetry based on 3 or 5. Ask the teachers to look for examples of such natural symmetry and relate this to their mathematics curriculum. In many cases, it is appropriate to use the natural environment to introduce the topic in a meaningful and concrete way.

Angles in Nature

When sand is poured on to a flat surface it forms a cone at a particular angle. Leaves are displayed at an angle to the sun and branches are at an angle to the main trunk of a tree. The triangulation method for estimating the height of trees can make a geometry class more active (Include formula). Compass directions and pacing to estimate measurement of large areas as well as distance estimates and directionality can assist mapping skills, which are also useful in social science and other environmental education activities. Ask the teachers at the Workshop to think about possible class activities associated with angles in nature.

Areas in Nature

There are many ways of estimating the area of irregular shapes. These include the use of a grid and counting all squares which are more than half covered or covering the squares with standard objects (e.g. bean seeds). Suggest to the teachers at the Workshop, that they could use this method to find the average area of leaves on a nominated plant. This could be followed by a brief class discussion of the importance of trees and shade.

Volumes in Nature

There are few objects in nature which are sufficiently regular to enable the use of formulae to calculate volume but a useful method for determining the volume of solids is through displacement of water. The children could estimate, then measure, the volume for a range of things found in the environment, e.g. rocks, shells, etc.

IMPORTANT:
Once the teachers have undertaken these activities in groups, they should write them down and exchange with the other groups so that each activity devised is physically trialled by the other groups of teachers to help clarify instructions, provide feedback and promote teacher confidence. Now introduce a more detailed lesson plan as follows:

Lesson 1: Environment and Maths: Forestry

(Adapted from Lesson Plans from Solomon Islands)

Measuring Logs

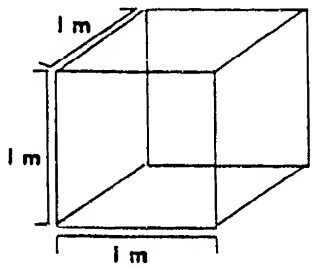
Teachers can begin by explaining to the children the importance of trees to the well being of their environment and the need for good forestry management practices. Further, they can explain that if overseas companies are going to cut and take away trees, it is important that the government, as well as the people who own the trees, should receive reasonable amounts of money for what they sell. There are four things which affect the amount of money that landowners and the government receive for the trees:

1. The way trees are measured.
2. The way trees are classified.
3. The way timber owners get paid by the company.
4. The way the company sells its timber.

In each of these, there are ways which companies can reduce the prices paid to timber owners and although most companies do not do this, it is important to understand what could happen. Logs are bought and sold by measuring the volume of the wood in the log in cubic metres. Landowners are usually paid a certain amount for each cubic metre cut from their land, and companies sell logs overseas by the cubic metre. Usually the branches and the bark of the tree are not useful for sale, so these are cut off and the straight part of the trunk is measured and sold as a log.

Procedure:

To help the class imagine what 1 cubic metre of wood is like, find a table or other object about 1 metre x 1 metre, or draw a square this size on the board.



Explain to the class that a log is a cylinder and ask them to recall the formula they have learnt in Maths for measuring the volume of a cylinder? (Volume = π x diameter squared x length). Then ask the class, what difficulties they might encounter in measuring the volume of a log like the one below. (Is it a **regular** cylinder?)

Explain then that logs are usually wider at one end than the other. They are irregular - not perfectly cylindrical and they are not perfectly straight. To measure the exact volume would be impossible, so loggers usually agree to use the Brereton Scale, which gives a good estimate of the volume. This means they use the usual formula for the volume of a cylinder (Volume = ¶ x diameter squared x length) but because the diameter is different all over the log they take the average of 4 diameters. At each end they measure the longest diameter and a diameter at right angles to this.

The average diameter is then calculated:

$$D = \frac{D_1 + D_2 + D_3 + D_4}{4}$$

So Volume of the irregular log = $\pi \times D^2 \times L$ (using the above formula to obtain the average diameter)

Ask the class to calculate the volume of a log with the following measurements:

D_1 = 50 cm. or O.5 m.
D_2 = 40 cm. or 0.4 m.
D_3 = 60 cm. or 0.6 m.
D_4 = 75 cm. or 0.75 m.

Length = 1,000 cm or 10 m.

If the company pays the landowner $ 10 for each cubic metre, how much would the landowner get for this log?

B. The Environment and Language

The Language curriculum offers a wide range of opportunities for incorporation of environmental concepts. If the teachers learn by doing these activities at the Workshop, the same or similar activities can more easily be transferred to the classroom. When the teachers become enthusiastic it will automatically rub off on their students. At the Workshop have the teachers prepare some of the following activities:

Story

To show the effect of pollution on marine life, a story could be written in class with suggestions from the children or individually by each child. An example is as follows:

"I'm Swimmy the fish and one day I decided to visit my uncle on the island of..... . I was very excited because I had heard about all the beautiful....., ..., ..., ..., ..., ..., on the island. But as I came closer and closer to the island I began to see strange things that I had never seen before floating in the water."

The children could finish this story with Swimmy wondering what these things were and what kind of people lived on the land who would throw such things into the ocean. He could meet up with his uncle who might explain pollution and how his life has changed because of it. This could move Swimmy into some kind of action to stop pollution in his waters. This method could be used to create awareness of the problem, but also could lead to action by the character in the story. These stories should then be shared with the class, sent to Environmental organisations, or shared with other classes or schools.

This is only one example and many more can be created by the teacher and children for any environmental concept studied such as overcrowding, deforestation or tourism.

Informational Paragraph

Island animals and plants can also `come alive' and many environmental concepts and facts can be taught through the eyes and mouth of an animal. A series of informational paragraphs could be developed by having each child write one. An example might be:

> *"I am a gecko. I live in Joe's home on the island of..... . Everyone in the house has a special job to do, and my job is to catch insects, bugs and cockroaches."*

These paragraphs could be placed on cards and the children could have fun using them as a quiz or review of knowledge about the importance of each animal, insect, bird or plant in their environment.

Front	Back
I live in Joe's house. I catch insects, bugs and cockroaches	gecko

The process could be reversed, i.e., give the name and ask the children to state its importance.

Labelling

Children love to draw and always seem to be drawing even when they should be doing something else. Therefore, teachers should tap this resource for educational purposes. Ask the children to draw pictures of the natural landscapes of their islands. Ask them to make it a simple drawing which could include other islands around them, lakes, hills, mountains, rivers, mangroves, beaches, clouds, forests, waterfalls and whatever else might be part of the island environment. Then the class could be asked to label these features with the English name and the name in the vernacular. These could be written directly on the drawing or could be written on small cards which could be stuck on with tape or pins. If the latter method is used it could serve as a review evaluation. The children could test each other. The drawings could be done outside where the students draw what they see on their school grounds. Then the labelling could be done when they come back into the classroom. This could also be done with a marine resources lesson on a trip to the sea. Always use English and the names in the vernacular if both are available.

Spelling Lists

Spelling lists in English and the vernacular could be made up from the words used in the observation. This list could also be used as a word resource bank when the students are writing stories, poems, letters, puppet scripts, and dramas.

Letters

Letters could be written to children of other islands or countries telling them about the trees on the children's own island and asking if the same trees grow at their place. This would be especially valuable for findir out the differences and similarities among the flora (and fauna) of high islands and atolls. For older students, by asking the question: "Are any of these trees endangered?" one could lead into a study of forestry on the island especially incorporating environmental and economic issues.

Role Playing

Role playing is another activity in which children can express their knowledge of environmental issues. Using the theme of trees, one child could take the role of a tree which is to be cut down to make room for a home or hotel. Another could take the role of the home owner who could not care less that a tree has to be cut to provide room for his house. A dialogue could be written by these children and presented to the class.

Drama

Drama is another area in which environmental education can be stressed. Groups may like to compose dramas about trees and perform them for the class or school. This develops writing skills, speaking skills, acting skills, art skills in making props, organisation and leadership skills, and most important, a knowledge about the subject. Here we use the example of trees, but it could be any environmental concept such as garbage, oil pollution, or erosion.

C. The Environment, Art and Music

Sketching

Beginning as early as first grade, the students can draw an accurate sketch of a tree of their choice, labelling each part correctly. This could be done outside as they sit under or near the trees. It is important for students to have knowledge and facts along with proper attitudes and aesthetic values. Both are needed to be able to make wise choices and decisions especially in environmental education. This 'scientific' drawing should be distinguished from an artistic expression' where trees could be purple and even square. Further discussion could revolve around the questions: "What would be the immediate and long range effects if this tree or group of trees were cut down or blown down by a storm. Has this happened in the past, and, if so, what were the results?"

Leaf Rubbing

The children could be asked to bring a leaf to school which could be used (a) for a leaf rubbing, (b) to compare shades of green and (c) to examine the vein structure. The leaf rubbings (produced by putting the leaf under a sheet of paper and rubbing over the paper with a crayon until the leaf outline appears) could be cut out and made into a huge tree in the classroom. Poems and stories about the tree could be hung on this artificial tree.

Murals

Murals could be made depicting trees and their habitats. For younger children, the playground setting for the trees would be sufficient. The children could use different media such as paint, folded paper, actual leaves and twigs. Into this mural could go the animals, birds and insects, living in, on and under the trees. Again these could be made using a variety of materials. People could be placed in it to show the harmony of humans and the environment.

Music

Music is a very effective medium for environmental education. The students could sing a traditional song about trees and plants. They could also take a familiar tune and write new words for it about trees - their uses and value. These songs could then be sung for another class and used for a special programme performance. This could be a whole class project or a small group project.

Puppets

Puppets can be used very effectively, especially with younger children. The teacher could write a script and make a puppet (very simple such as a tree stick puppet) or the students could write the script and make the puppet. Again this show could be presented to the rest of the school. Very few materials would be needed and you could use natural products like twigs and leaves to make a tree, an animal living in that tree, a person or whatever characters are needed. Children on all islands have great imaginations! Let them create!

> **REMEMBER:**
> At the Workshop, all ideas should be exchanged so that the teachers can build up a collection of resources for use with their classes.

D. The Environment and Social Studies

Mapping

Mapping activities in social studies can be a useful means of developing awareness and understanding of environmental issues and for communicating plans for environmental action. The kind of map to be used or developed depends on the objectives in mind. Although we are referring here to social studies, mapping studies also have a place in a number of areas in the school curriculum including art, science, and mathematics. There is a variety of different kinds of maps ranging from a young child's informal drawing of the main landmarks seen on the way to school, through to the formal representation used by geographers. It is important that the children do not let the technical aspects of map-making interfere with the primary aim of environmental awareness. Some suggested mapping activities are listed below:

- **Developing general maps of an area** to describe what is present and to develop greater awareness of the nature of that environment. These maps can range from simple sketches which show such things as buildings, vegetation and other features and their appropriate arrangement, to scale representations which use symbols instead of pictures. Sketching an area is useful on any field trip as it encourages pupils to look more carefully at the area and gets them actively involved in reporting what they observe. They should gain experience in mapping a range of different environments including urban landscapes, villages and small communities, agricultural areas, and natural bushland and forests. In this way they can begin to appreciate the management/development continuum.

- **Developing maps as future plans for an area.** One way of getting the children to understand the complex interrelationships involved in towns, cities and rural areas is to have them develop plans to show the way they would like to see the land used and then to compare this with the present use. Designing a town involves making decisions about where to place houses, factories, schools, shops, hospitals, churches, roads, parks, and other infrastructure. This can be done as a group project and will generate considerable discussion and lead to an understanding of environmental planning issues. For younger children this can be done in a sandtray using various objects to represent such facilities as houses, shops, and the school.

- **Using maps of particular areas for specific purposes.** If we know the purpose then we can select the appropriate map. For example, if we wish to develop an understanding of the damage which might be produced by a nuclear bomb or by the Greenhouse Effect' and associated sea level rise, then we might wish to use a large outdoor map drawn on the playground with prominent landmarks or features represented by models. From this map it would be possible to nominate a centre or area of most damage and gauge impact by drawing various zones of destruction.

Community Use of Natural Resources

Discuss the role of trees in the neighbourhood or around the house. For instance, maybe there is a certain tree where the old men of the village congregate to discuss village matters; a tree where the young men go to sing or just hang around; a special tree used for making local musical instruments or tools; or a special tree used for fire wood. Each island would have its own special trees. If possible, see if an older person from the village would be willing to come to the class or meet the class at the tree to discuss its significance.

Studying the Built Environment

Much of the urban environment has been built by people. However, although there is an interest in preserving historic buildings little attention is usually paid to other aspects of the built environment (roads, bridges, buildings, canals, powerlines, towers, waste-disposal centres, etc.). Some useful activities relating to the built environment are as follows:

(i) Walk around an **urban area** to survey the age and type of buildings and related structures, taking note of differences in materials used and their state of preservation. Look to see where living things have begun to colonise these structures.

(ii) Keep an **energy diary** - record all the energy used in your home over a period of one week, including your own energy supply.

(iii) Keep a **record** of everything which enters and leaves your home over a period of one week, e.g. foodstuffs purchased, items disposed of, etc.

(iv) Conduct an **urban garbage** survey to determine its average composition. Consider what could be done with this material.

(v) Survey the number and kind of organisms in several parts of the urban environment. Compare and contrast the populations in these areas.

(vi) Conduct a **traffic survey**. Determine the number and type of vehicles travelling on a given road at various times during the day. Take note of what is being transported (e.g. produce, building materials, and people)

E. Integrating Environmental Education

The following is an activity which incorporates environmental education into an integrated activity using the theme of **Trees.**

Activity: Observing trees in the playground or surrounding area.

Classroom Preparation before the Activity:

These can be adjusted according to the grade, level or form taught. The teacher will try to encourage the students to respond with their background knowledge, and these responses should be recorded on the chalkboard.

(a) Find out from the class what kind of trees they would expect to find in the playground or surrounding area. English and local names could be used. Save this list as the names could be used for a spelling or writing lesson.

(b) The teacher or a pupil, depending on the age level taught, could draw a diagram of a tree on the chalkboard. Have the class name the parts of the tree and the teacher/pupil write the names next to the corresponding part. For very young children the teacher could use this time to teach them the names - roots, stem or trunk, leaves, branches.

(c) Find out from the children what birds, animals or insects they think might live in the playground trees. Record these so that the class can compare their pre-walk `guesses' with their `actual observations'.

(d) Discuss the use of our five senses (smell, taste, touch, hearing, sight) in gathering information about the environment. Ask the class what senses they will use when they go outside to observe the trees?

- ❑ Explain to the children not to put any part of the tree in their mouth as it may be poisonous or harmful to them.
- ❑ Encourage the class to listen to the trees (leaves rustling, bamboo scraping against each other) and ask them whether the sounds made by the tree are loud or soft, pleasing or harsh and whether different trees produce different sounds?
- ❑ Encourage the children to feel the bark and the leaves and ask them whether they are rough or smooth?
- ❑ Encourage the children to smell the leaves and the bark and ask them whether each tree has a distinct odour?
- ❑ Ask the children to look at the trees to see if they have different sizes, shapes, colour, leaf formation; how they are arranged on the branch; whether they have smooth or jagged edges; what type of bark, root systems, etc. The teacher could have samples (real or pictures) of each of the above categories to show the children. Explain to the children that they should look for these differences in the trees they see on their walk.

The Walk Outside:

Materials:

Paper and pencil (also clipboard, if available)

Organisation:

- ❑ The children may work individually or in pairs. They can share knowledge.
- ❑ The teacher should define the area in which they will work.
- ❑ Set a time limit. 15 minutes approximately.
- ❑ Make sure the children know what they are to look for.
- ❑ Ask the children not to disturb other workers except to ask a relevant question about the task at hand.
- ❑ Ask them not to pick any leaves or break off any branches.

Procedure:

- ❑ The children should write down all the observations they make about the trees. In the case of very young children, they can draw what they see.
- ❑ Remind the children to use all their senses except taste and write down what they smell, feel, hear and see (colours, sizes, shapes of leaves, trunks, branches, animals, insects).
- ❑ Encourage the children to use descriptive words in the observations. Maybe a lesson describing objects (nouns or adjectives) should precede the walk depending on the language experience of the students.
- ❑ These could then become part of a spelling or writing lesson.
- ❑ The teacher could guide the children to different trees so that they do not all crowd around one tree at the same time. She/he should be there to answer any questions, but otherwise remain in the background.

Post Walk Activities:

When the children come back into the classroom, the teacher or a child should list all the observations on the chalkboard according to the sense used. Then these could be categorised again into physical aspects, aesthetic aspects, living organisms in, or on, the tree etc. Using one of these categories, the children could write a short informational paragraph about one of the trees, or for younger children they could draw their tree. Let the class suggest the categories. The teacher can supply any that are missing.

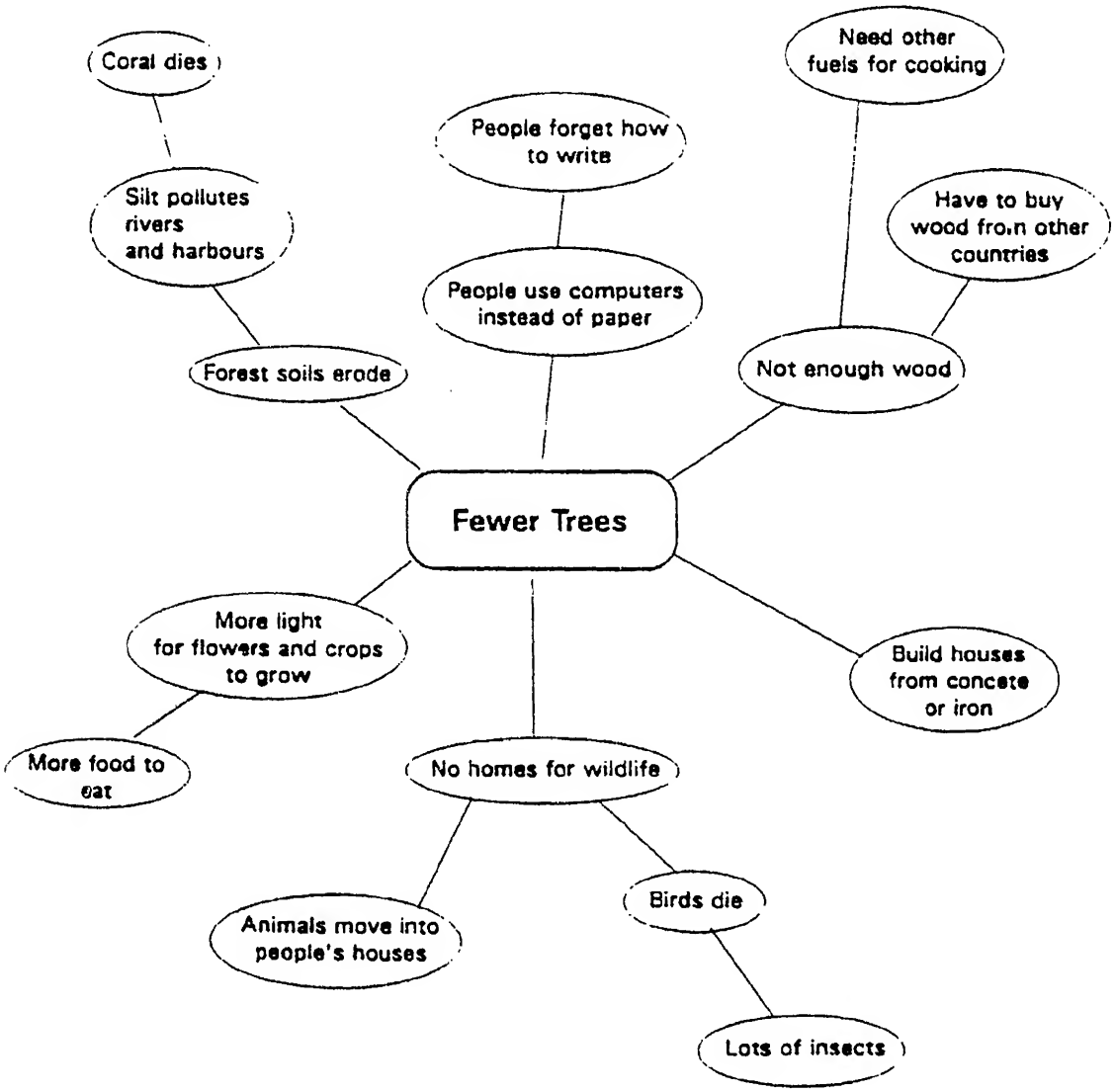
Ask the class to describe what would happen if someone came and cut down this tree (in the play-ground) for firewood, to build a house or shed, or if a typhoon or cyclone blew it down? (loss of shade, loss of habitat for the animals, birds and insects listed earlier, etc.)

At the Workshop:

Have the teachers undertake the above activity and, on completion of this 'learning-by-doing' lesson, discuss with them how they felt when they were going through the activity. For instance, whether they liked it and whether they feel they could now teach some environmental concepts using an 'activity-based' method.

Activity Extension:

This activity could be extended to develop a *Futures Wheel*. The teacher could ask the children to think about what might happen if there were fewer trees on the island or in the world. He/she could then collect their ideas on the board, interconnecting possibilities. This could end up looking like this:



A wall chart of the wheel could then be made and illustrated and a further question asked: "What should we do if a tree is cut or blown down?" (Plant another one, if possible). With older children this could lead into a discussion of urbanisation and over-population. The teacher could beforehand find books and poems in the library or passages in the Reading textbook dealing with trees and plants and read them to the class, or the children could be asked to read them. The children could write a story about their tree; about how it might feel standing tall looking out over its beautiful Pacific landscape; about how it might feel if its neighbouring tree was cut and destroyed; or they might choose to write a descriptive poem about the tree.

F. Using Activities and Developing New Ones For Environmental Education

This Unit of the Manual has tried to give teachers an idea about how environmental education could be taught - the methods. The Manual also contains four additional Units that each give background and information about one environmental issue and activities that could be used to teach the Unit at the primary or secondary level. The following will show teachers ways of using and evaluating the activities in the Units on the Marine Environment, Pollution, Agriculture, and Traditional Environmental Knowledge.

Analysing Activities for an Issue

This is designed to guide a teacher to look over the activities of any issue to determine:

(a) at which level they would be taught?

(b) what changes could be made to teach the activity at another specified level?

(c) what are the activity's objectives?

- ❑ awareness and understanding
- ❑ skills
- ❑ values
- ❑ decision making action

At the Workshop:
Divide the teachers into groups and have them analyse and discuss the activities in the other four units of this Manual. Have each group fill out a chart like the one below for the activities.

Level and Scope of Environmental Activities Overview

Issue Area _____

Put a tick next to the areas where each activity applies

Activity	Level (year)	Awareness/Skills Understanding	Values Making/Actions	Decision

The teachers should then report back to the Workshop with their analysis of the other Units and discuss what activities one might use in class. They should also discuss what activities need to be developed further and how a specific activity could be modified for another age level.

Where in the Syllabus / Curriculum Should I Teach This?

Each teacher should select one activity they have seen and indicate where they could use it in the syllabus/curriculum they are now teaching. All should report back to the group so that teachers can record where activities could be used to supplement the programmes they now use.

Identifying Local Resources

Most teachers have a wealth of resources in their schools or communities that could be used by them and their students to learn about the environment. For those in the remote schools this may consist of the surrounding environment like the reef, the school yard, the forest, or the agricultural land. In the urban areas, many of the above are more difficult to use but there is access to people and organisations capable of providing a wide range of materials and assistance in teaching environmental concepts.

The following is a workshop activity to develop a list of local resources for use by the teachers when they return to their classrooms.

Workshop Activity : Brainstorming Your Own Resources

- ❑ Teachers should divide into groups.
- ❑ Each group should select a reporter to record what people say (short quick one or two word notes).
- ❑ Each group is to identify as many resources as they can think of in two minutes. Think of as many people, places and things as you can. An 'award' could be given to the group with the most, if it is regarded as desirable.

RULES

1. Time for this activity is **only 2 minutes.**
2. NO judgments should be made. ALL ideas should be accepted equally. NO ideas should be criticised - accept everything!
3. 'Stairstepping' should be encouraged. When one person gives a resource another may get a similar, or another, idea from it. Record all.

- ❑ At the end of two minutes have the groups stop and the teachers reassemble into the larger Workshop group and write up their ideas on the blackboard, overhead projector or newsprint. Participants should either copy or get a copy at the end of the workshop of these resource suggestions.

- ❑ Discuss these resources and what is available and add others that may come to mind. Be specific as to a person's name or the name of an organisation. (See suggestions below).

Here are some possibilities the teachers may come up with:

- ❑ **Village and traditional expertise.** Fishermen, farmers, leaders, traditional doctors, etc. Remember that in some islands this information is considered sacred or privileged information and not to be shared with just anyone.

- ❑ **Government officials and offices.** These people and organisations offer a wide range of expertise and support for environmental education. The workshop leader should consider inviting these people: (1) to the workshop to share what they can provide to the teacher and 2) to the classroom to provide environmental information to the students, e.g. Universities, Ministry of Agriculture, Forestry Department, Environmental Protection Agency (EPA), Bureau of Tourism, Department of Public Works, Hospital/Health Department.

- ❑ **Informal resources.** Newspaper clippings, magazines, pictures, books, collections of rocks, shells, leaves, etc.

- ❑ **Printed and audio-visual material.** Most islands have a central resource centre/library with films, books, and now videos that can be checked out by teachers. Resources such as videos, slide programmes, booklets, posters, jigsaws and environmental resource kits are available from the South Pacific Regional Environment Programme (SPREP), B.P. D 5, Noumea, New Caledonia.

- ❑ **Students.** The children themselves are often a valuable resource in finding materials and sharing the things they find.

- ❑ **Other teachers.** Colleagues at the school may have information about resources which they might be willing to share.

Influencing Other Teachers

An appreciation of the need to protect the environment will be accompanied by the need to convey this message as quickly and widely as possible. The classes and teachers of the region provide opportunities to do exactly that. Even when environmental education / science studies is not a named subject in the curriculum, we have shown extensively in this Unit that environmental concepts can still be introduced and incorporated.

At the Workshop, discuss with the teachers ways in which they can influence other teachers to see the need for, and gain confidence to include, environmental concepts in their learning / teaching activities.

- ❑ Display posters and samples of the children's work in the classroom and elsewhere around the school.

- ❑ Let other teachers have access to the resources prepared or collected.

- ❑ Invite a resource person to the classroom and invite another class to come and share their expertise.

- ❑ Invite other teachers to help on field trips or excursions.

- ❑ Keep a diary outlining the planning and undertaking of particular environmental education activities. Publish extracts in teacher's journals, or send to teacher trainers for them to use.
- ❑ Offer to run inservice courses within the school or district to pass on the information learnt at this Workshop to other teachers.
- ❑ Arrange for environmental education themes to be covered in daily newspapers in a form suitable for classroom use.
- ❑ Run a school-wide competition on an environmental theme.
- ❑ Organise school activities, in co-operation with government departments and non-government organisations, for a National Environment Day / Week celebration.
- ❑ Others (Discuss with the teachers other ideas and their practicability).

Unit Two:

Marine Environment

Introduction

There is a wide range of interrelated ecosystems in the marine and coastal environment of our Pacific islands - an *ecosystem* being the collection of different livings things and the environment (surroundings) in which they live. These ecosystems can be broadly divided into the following categories:

- ❑ Coral Reefs
- ❑ Beaches and Seagrass beds
- ❑ Mangroves
- ❑ Estuaries
- ❑ Lagoons
- ❑ Ocean Waters

In these ecosystems the organisms (animals and plants) are variously adapted to their environment which has produced a diversity of life, a complex network of *interrelationships* among the organisms and between the organisms and their environment.

The marine environment is fragile and therefore it needs protection. It is important that when we use marine resources we ensure that we use them carefully and leave enough of the resource to enable it to continue to provide for our needs and those of future generations. This is called *sustained yield.*

The objective of this section on Marine Environment is to ensure that after undertaking the activities, the children should:

(a) develop an awareness and appreciation of the physical and biological components of the marine environment;

(b) understand a body of knowledge, skills and attitudes associated with the study of the marine environment;

(c) appreciate the value and significance of the marine environment and its resources through practice of, and support for, conservation activities and sustainable resource management; and

(d) appreciate the appropriate use of both traditional and modern knowledge and practices to conserve and sustain the marine environment.

Unit Components

The Marine Environment can generate many topics for learning/teaching activities. In this unit, however, we have concentrated only on four topics, each of which contains a number of classroom and field activities, namely:

A. Sea Water
B. Coastal Environment
C. Marine Life
D. Coral Reefs

Topic A: Sea Water

The medium within which all marine organisms develop and survive is called marine or sea water. More than two-thirds of the world is covered with water and this water is divided into fresh and marine (sea) water. The marine water is further divided into oceans and seas. The Pacific islands are located in the biggest ocean, the biggest body of marine water in the whole world. The seas and oceans surrounding each island or island group play a very important role in the weather and climate of these islands which further affect the well-being of the myriad of organisms in the Pacific ecosystems. Sea water is therefore a very important component of the marine ecosystems.

Sea water has a specific odour related to its many organic components, as well as to its various salts. We are all aware of the refreshing smell of salt water breezes which we can usually smell some distance inland. The salts in sea water are combinations of many elements, the chief salt being sodium chloride (ordinary table salt). The total amount of salt in sea water is, on average, approximately 35 grams per 1000 grams of sea water.

By contrast, average drinking water only contains trace salts to a level of about 0.05 parts per 1000. Of the 35 parts per thousand of salt in sea water, about 33.5 parts are sodium chloride or ordinary table salt, the remaining 1.5 parts per 1000 including many elements, among them uranium, copper, aluminium, manganese, silver and gold. Iodine is also present in trace amounts (0.0035 parts per million or 0.0000035 parts per 1000) in sea water, and is most concentrated in certain seaweeds and sponges. Iodine, like very many other elements and compounds, can be harmful at some concentrations and can be a beneficial drug or even a food at other concentrations. For example, total lack of iodine in human beings produces a condition called goitre. Sea water also transmits sound considerably better than does air. Fish communicate by sound and at times become "noisy".

Most Common Elements Which Make up Salts in Sea Water

Element	Parts per Thousand
Chlorine (Cl)	18.98
Sodium (Na)	10.56
Magnesium (Mg)	1.27
Sulphur (S)	0.88
Calcium (Ca)	0.40
Potassium (K)	0.38
Bromine (Br)	0.065
Carbon (C)	0.028
Strontium (Sr)	0.013
Boron (B)	0.005

The topic of Sea water enables us to investigate such concepts as:

- ❑ buoyancy,
- ❑ salinity,
- ❑ turbidity,
- ❑ pollution, and
- ❑ temperature change.

Activity 1: Investigating Sea Water and Tap Water

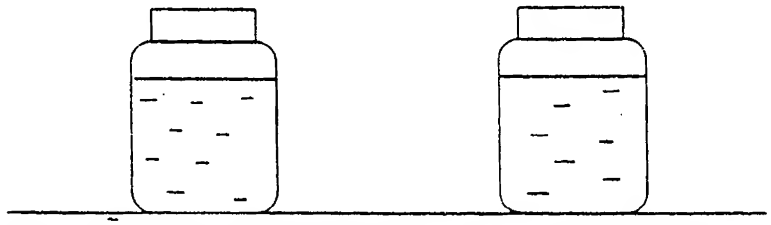
A component of tidepools and reef flats which merits more attention than it usually gets is sea water itself. This activity is intended to heighten awareness of the special characteristics of sea water through observation of its properties.

Materials:

- ❑ sea water
- ❑ tap water
- ❑ two jars per group of students
- ❑ newspapers or old cloth for desk or tables

Procedure:

1. Divide the children into groups of three or four. Give two jars to each group, one containing sea water and the other tap water. Mark the jars in code so that only you know which is which.



Two unmarked jars; one containing fresh water, the other sea water.

2. Before the children insert their fingers to feel or taste, ask them to predict whether there is a difference between the two types of water.

3. Ask them to look carefully at the two jars. Can they observe any difference or identify which is which?

4. The children should then look at, smell, feel, and taste the contents of both jars to check on their predictions. Regarding the tasting of sea water, any sea water which passes the health requirements for swimming is probably safe enough to dip one small finger in to taste a few drops. An added precaution, if desired, is to boil sea water for about ten minutes the day before it will be used by the class. Let it stand and cool to room temperature.

5. In addition, the children could test for hearing through water. They can press an ear against one side of a jar of water while someone taps the other side of the same jar. Then listen to the same tapping without an ear pressed to the glass. Actually, this tests for sound conduction through glass as well as through water but testing sound conduction with ears immersed in water is a bit too wet to try in a classroom situation.

6. Younger children can discuss what differences they find in look, smell, feel, taste, and sound of the two water samples. Older children can record data on a table of their own devising or in a table like the following:

Differences Between Salt Water and Fresh Water

Characteristics Tested	Predicted Differences Between Salt and Fresh Water	Tested Differences Between Salt and Fresh Water
Appearance (look)		
Smell		
Feel		
Taste		
Sound		

7. A class discussion may be used to consider the data concerning predicted and actual experience of look, smell, feel, taste, and sound conduction through salt and fresh water. The following questions may help to promote further discussion aimed at greater awareness and appreciation of the properties of sea water.

- ❑ What do you think causes the differences you found between salt and fresh water?
- ❑ Where do you think sea water comes from? (ocean)
- ❑ Does anyone know where tap water comes from? (water pipes, pumping station, rain, ground, etc.)
- ❑ Do you like the 'feel' of water?
- ❑ What do we use fresh water for? (drinking, washing, bathing, cook, watering gardens, swimming, navigation on rivers, etc.)
- ❑ What do we use sea water for? (swimming, aquaria, fishing, ship transportation, etc.)
- ❑ What would our world be like if we had no ocean? (no seashore, no sea animals, etc. More advanced classes might get into oceans as a source of rain, a weather regulator, ocean industries and resources.)
- ❑ Should we take care of our water and of our ocean? Why? How can we take care of water?
- ❑ What should we **not** do to water and the ocean?

(Activity adapted from Hawaii Nature Study Program: Reef and Shore)

Activity 2: Buoyancy of Sea Water and Tap Water

Materials:

- ❑ sea water in jar
- ❑ tap water in jar
- ❑ miscellaneous small objects, some denser and some less dense than water

Procedure:

1. Introduce the activity by asking the children about floating and sinking based on their own experiences. For example:

   - ❑ Ask whether a soap bar floats or sinks in the bathtub, and why?
   - ❑ What else floats or sinks?
   - ❑ Will these objects float or sink the same way in sea water as in tap (fresh) water?
   - ❑ Encourage student questions and opinions.

2. Allow the children to collect objects from their own desks at school or to bring objects from home. Objects may include wooden pencils, paper clips, corks, pieces of wood, soap, paper, plastic ruler, pins, plastic lids, sponge, etc. Ask each group to sort their objects into two piles:

   - ❑ objects they predict will float, and
   - ❑ objects they predict will sink.

3. Give each group of children two jars, one of sea water and the other of tap water in which to test their predictions. Older children should record their work in a data table as shown below:

Buoyancy of Sea Water and Tap Water

Name of Object	*Sea Water*		*Tap Water*	
	Prediction	Actual	Prediction	Actual

Entries in the columns may include such remarks as `floats', `barely floats', `sinks', `floats higher than in salt water', etc.

From the results collected and through a class discussion, draw conclusions about the buoyancy of sea water versus tap water. Hopefully, student observations were sufficiently careful so that they have noted that salt water holds objects higher out of the waters or conversely objects sink deeper in fresh water.

(Activity adapted from *Hawaii Nature Study Program: Reef and Shore)*

Activity 3: Quantity of Salt in Sea Water (Salinity)

Material:

- ❑ sea water
- ❑ flat basins, dishes or plates
- ❑ magnifying glass or a microscope
- ❑ weighing device (optional)

Procedure:

1. Start this activity by asking the class "How much salt is in sea water?" "How can we get salt out of the sea?" Some children may suggest that salt is recovered from sea water by evaporation. But since salt in sea water is invisible, some may think it is not possible to evaporate water leaving the salt behind. The only scientific response to this doubt is to test the process.

2. Put about a half inch or less of sea water in flat dishes or the equivalent. Let these stand for one or two days in the classroom to allow evaporation. A quicker alternative is to gently heat pans of sea water on a stove until evaporation is complete.

3. Examine the residue salt crystals with a magnifying glass or microscope. Note shapes, sizes, taste, colour, and feel of the crystals. Compare these with packet salt from the shop.

4. Ask the children to predict whether or not these salt crystals could be redissolved in water. Redissolve them and note their 'disappearance'. Again compare sea salt with packet salt from the shop.

5. For older children more accurate measurements can be made. Measure a quantity of sea water into a dish for evaporation. Use a quantity which will simplify calculations. If possible use one litre, or at least an easily calculated part of a litre. Evaporate to dryness. Measure the dry salt residue by volume or by mass. (**For calculation:** 1 litre or 1000 ml of pure water has a mass of 1000 g or 1 ml of water has a mass of 1g).

6. **Measure by Volume.** Put the salt obtained by evaporation into a graduated cylinder or measuring spoon. Take the reading in ml or teaspoons of salt. This method suffices for in-class comparisons.

$$\text{ml or teaspoons of salt} = \frac{\text{ml or teaspoons of salt per litre}}{\text{litres of water}}$$

This can be considered the "class standard" for sea water.

7. **Measure by Mass.** Weigh the salt obtained by evaporation in grams on a balance. Textbook standards are done by mass so this method will allow comparison with the standards. One litre of water is 1000ml and has a mass of 1000g. One ml of water has a mass of 1g. Calculate the proportion of salt in sea water.

$$\frac{\text{grams of salt obtained}}{\text{litres of water used}} = \text{grams of salt per 1000grams (litre) of sea water}$$

According to standard calculations, sea water contains 35 grams of salt per 1000 grams of water. This is expressed as:

35 parts per 1000, or
3.5 parts per 100, or
3.5% salinity.

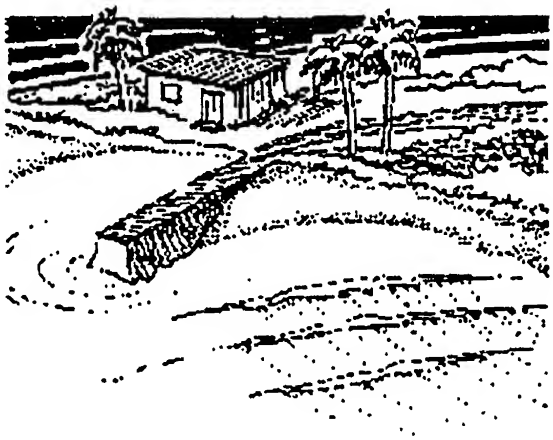
Compare student results among tests made by various groups in the class with the standard of 3.5% salinity.

8. Discuss discrepancies, if any, between the class results and the standards.

   - ❑ Does the class agree that it measured 'standard' sea water
   - ❑ What is standard sea water?
   - ❑ How about sea water offshore after rain, or sea water near a river mouth?
   - ❑ Does rain on the ocean make a difference to the salinity on the ocean surface?
   - ❑ Where did the sea water used in the class tests come from?
   - ❑ Was there a possibility of human error, such as spillage of salt or water during the measuring process, or misreading of amounts?

9. Students should write a report of their experiment, calculations and findings.

(**Activity** adapted from *Hawaii Nature Study Program: Reef and Shore*)

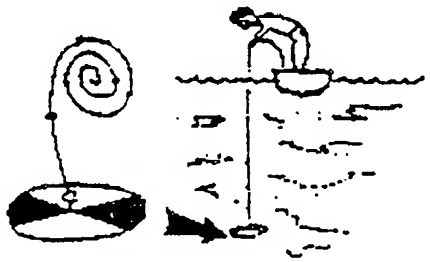


Activity 4: Water Quality Survey (Field Activity)

Most water pollution measurements require sophisticated techniques and equipment. However a few simple indicators can be used to determine the general quality of coastal waters. This activity aims to survey the water quality in a coastal area; to relate the water quality to other observations on the state of the environment; and to understand the effects of man on his surroundings.

Material:

- ❑ Thermometer
- ❑ Secchi disk (20 cm weighted black and white disk attached in its centre to a rope marked in metres)
- ❑ Tape measure (10m. or more)
- ❑ Metre stick
- ❑ Sieve (2 mm. mesh size) or mosquito netting.



Secchi disc to measure turbidity

Procedure:

1. Choose two (or if possible more) survey points at half kilometre intervals along your nearest harbour, bay, beach or other coastal feature.

2. At each survey point, take and record the temperature in shallow water (5-10 cm depth) and also, if possible, in deeper water. A higher temperature inshore than offshore may be a sign of poor water circulation; a lower temperature may indicate groundwater seepage or other fresh water input.

3. Lower the secchi disk (see previous diagram) until it is no longer visible from the surface, and note the depth on the marked cord. Slowly pull it up again until it is just visible, note the depth again, and average the two measurements. This will determine the light penetration in the water and is a good measure of turbidity caused by pollution or suspended sediments.

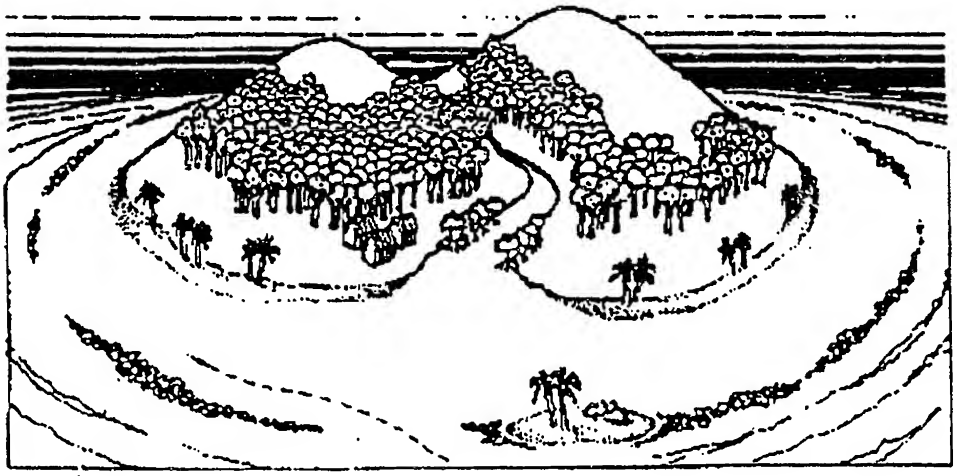
4. Get the students to walk along 100 metres of shoreline collecting or counting the number of pieces of rubbish observed (plastic bags, bottles, packaging, fishing gear, etc.). Calculate the pollution for each site in terms of the weight of the rubbish or the number of objects per metre of shoreline.

5. On returning to the classroom, students should draw a map of the coastline marking their survey points. They should draw in the points of known activities, e.g. factory, sewage pipe, etc., and see if any signs of pollution indicated from their survey correlate with these activities.

This technique can be used by classes each year for long-term monitoring. If signs of possible water pollution are identified, the class may want to present its result to local environment or health officials for possible confirmation and follow-up.

Topic B: Coastal Environment

The coastal region immediately fringing and hugging the edge of each island landmass is commonly referred to as the beach or seashore and it presents an interesting area of study. The topic of Coastal Environment enables us to investigate mangroves, beaches, seagrass beds, and the impact of tides, waves and wind on these areas as well as the impact as a result of pollution. This topic could also discuss the "Greenhouse Effect" and its associated climate change and projected sea-level rise.



Tides and Waves

Tides

Tides are wavelength waves produced by the general raising and lowering of the sea surface under the influence of the sun and moon. These tidal waves are usually from currents in a coastal region. Sometimes when the wave enters a narrow inlet of a bay, harbour, or river, the wave steepens forming a tidal bore. A tidal bore looks like a turbulent wall of water flowing inland from the ocean.

Tides result from the gravitational pull of the moon on the water of the earth and the centrifugal force of the earth resisting that gravitational force. The moon and earth attract each other by gravitation. If there was no resistance to this force, they would crash together. However, they whirl around each other creating a balancing force called centrifugal force which keeps them apart.

Centrifugal force is observed when we put water in a bucket and whirl it rapidly in a circle. The water does not fall out but instead pushes on the bottom of the bucket. In the case of tides in the region of the earth immediately beneath the moon, water is pulled toward the moon. On the opposite side of the earth, centrifugal forces pull water away from the earth opposing the force of the moon. The sun also exerts a gravitational force on the earth and produces its own tide. Again, opposing the tide is the centrifugal force of the earth as it wheels around the sun. As before, this centrifugal force pushes out a balancing mass of water on the other side of the earth because the earth's gravitational force is shifted towards the sun and moon. When the two tidal forces act together (from moon and sun) we get, over the course of a month, two days of extra high and low tides called spring tides.

Time and Tides. The moon passes overhead once every 24 hours and 50 minutes. If we are on the ocean on a calm day when the moon is overhead the ocean beneath us is at its maximum height or high tide. Six hours and twelve minutes later it is at its low tide.

Waves

Waves come in a variety of forms:

Radiating Waves move outward in concentric rings from the generating sources.

Parallel waves are sets of waves travelling together in the same direction with crests about equally distant from each other.

Reflected waves are formed by water bouncing off an object.

Refracted waves bend as they touch the bottom.

Converging waves come together creating a high wave which focuses in a small area.

Diffracted waves spread out and decrease in height and energy. A diffracted wave may occur, for example, when part of a wave passes through a small opening in the reef.

Activity 1: Wave Watch (Field Activity)

Material:

- ❑ Pen
- ❑ Paper
- ❑ Clipboard (if available)

Procedure:

1. Ask the class to explain what they know about waves. From this discussion you can develop theories or questions to be answered in the field observation.

2. Take the children to a safe vantage point at a nearby beach or surfing spot and have them sit quietly and watch the waves.

3. The children should then be asked to record their observations.

4. In class the children should be encouraged to share their observations and opinions and to determine whether the different theories were substantiated and questions answered.

Suggested Observations

(a) What shapes do waves have? Sketch the shape of the waves you observe.

(b) How do waves change in shape and size as they come toward the shore.

(c) In what direction do waves move? Is there a pattern to their movement? At what angle(s) do waves approach the shoreline?

(d) What colours are waves? How do colours vary in different types of waves?

(e) How do waves compare in height? Where, in relation to the shore, are the largest waves found? Do the largest waves always form at the same place?

(f) Are waves arriving at the shore always the same height? If not, is there any pattern in how the waves change height?

(g) How many times do waves break before they reach the shore? Do all waves break at the same place? Do they all look the same as they break?

(h) What kind of sounds and rhythm do waves make as they approach and break on shore.

(i) Look for protruding rocks, sea walls or off-shore islands. How do these effect the waves?

(j) Watch as waves break on sand beaches, on rocks or on sea walls. How high up on the shore does the water go when the waves break?

(k) Is the tide in or out? Notice whether or not seaweeds or barnacles on rocks or sea walls are exposed. Observe whether waves advance up to the highest wash marks.

(l) Watch the 'advance and retreat' of waves. How much of the water in a wave actually returns to the ocean? Are there times when the amount of water that rushes onto the beach seems greater than other times? When does this happen?

(m) Notice the patterns formed in sand as waves advance and retreat. Look also for evidence of sand being sorted by colour or size along the beach. Sketch observations.

(n) Notice the shape and slope of the beach. Does the beach slope gradually or abruptly to the sea? Does it have sudden step-like drops? Is the beach wider in some areas than in others?

(o) Do waves advance evenly up the slope of the beach? Are there regular indentations, called cusps, along the beach where the waves advance farther up the beach?

(p) Does the beach appear to be eroding or enlarging? Look for the presence of sandbars and spits. If a stream empties out on the beach, does it flow directly into the sea, or is the stream diverted or closed off by sand? How do waves seem to be associated with beach erosion or enlargement?

(q) Observe how experienced swimmers, surfers, and boaters enter the water. How do they manoeuvre through waves? Are there any areas they seem to avoid? What are the areas like where they enter? What are the areas like that they avoid?

(r) How have living organisms adapted to living in wave-prone areas?

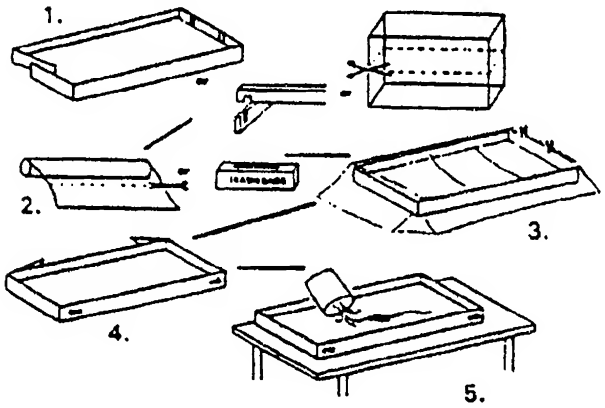
(Activity adapted from Living Ocean. HMSS. High School Marine Science)

Activity 2: Tides and Waves

Materials:

- ❑ Information on Tides and Waves (on the beginning of this section).
- ❑ A tank (1m x 2m x 12cm) constructed from boards and lined with 6 ml plastic sheeting (See instructions below). (Alternatively, use a large tub or a medium sized aquarium).
- ❑ A paddle or piece of timber almost the same width as the tank.
- ❑ 3 litres of washed sand of different grain sizes.
- ❑ 8 - 10 dense objects (pieces of coral, rocks) to resemble shoreline features
- ❑ Sponges

Constructing a Wave Tank



1. Construct tank from strong cardboard box or wood.
2. Use clear plastic or garbage bin liner to make the tank waterproof.
3. Cover inside of tank with the plastic.
4. Fit plastic sheet tightly over the tank.
5. Put tank on a strong table and fill with water.

Procedure:

1. Explain the information on tides and waves to the class.
2. Set the tank on a table.
3. Put the sand in the tank.
4. Fill the tank with 5 cm of water.
5. Place the objects, to represent one type of construction at a time, into the tank and determine how various types of coastal construction (jetties, breakwaters, sea walls) affect the formation of wave patterns. Jetties (are built extending out perpendicular to the shoreline). Breakwaters are constructed offshore to protect a beach from wave action and are usually parallel to the beach or to the pattern of prevalent incoming waves. Sea Walls are built to at the shoreline separating land from water and are meant to reduce shoreline erosion.
6. Generate waves for about 5 minutes after placing an object in the tank.
7. Have the students write down (or draw) their observations.
8. Discuss with the class what impact shoreline building and nearshore structures can have on coastal erosion.

Activity 3: Wind, Waves and Beach Features

This Activity is similar to the previous one and is used to investigate how waves interact with coastal features changing their shape and size. Under certain conditions, the energy in waves causes erosion. Under other conditions, the energy in waves causes accretion, or the building up of landforms). These changes are more apparent when waves interact with sandy beaches. In this activity, students will simulate in a tank, wind-wave formation, movement and interaction with coastal features.

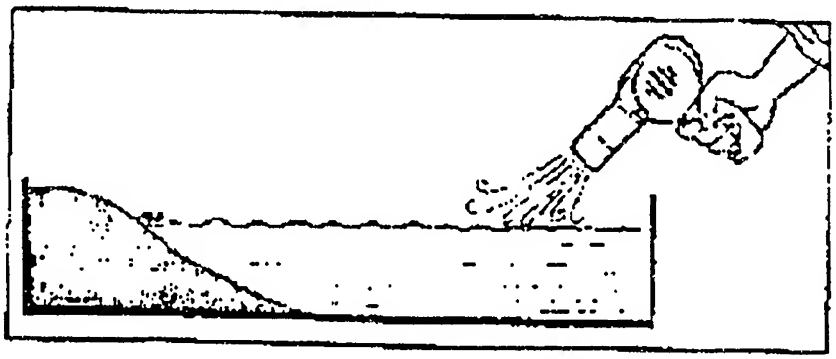
Material:

- ❑ Same tank as in Activity 2
- ❑ 4 litres washed sand, assorted grain sizes
- ❑ 1 variable speed electric fan or hair dryer
- ❑ metric ruler
- ❑ toothpicks

Procedure:

1. Assemble the tank or a plastic tide pool, fill with water to a depth of about 4 cm, and place the 4 litres of sand inside.

2. Simulate wind blowing over an open ocean in the tank. Use a variable speed fan to simulate a storm at sea.



a) Set up a high speed fan or hair dryer as shown above.

b) Position the fan so that it blows down at an angle of 10-30° onto the surface of the water. Turn the fan on to high speed.

c) Observe wind wave formation. Move around the tank to find the best angle for observing the waves.

d) Compare waves at the beginning, at the middle, and at the end of the tank. Students should sketch their observations.

e) Ask the students to identify and label the ripple, chop, swell and storm waves on their sketches.

Activity 4: Waves and Beaches

Material:

- ❑ Use the same equipment as in Activity 3.

Procedure:

1. Form the sand into a gently sloping beach that rises at the far end to about 5 cm above the water-line.

2. Place toothpicks every 5 cm along the shoreline of the beach. The shoreline is where water and sand meet.

3. Make 'before' sketches of the profile view and the aerial view of the beach. Use the diagrams below as a guide.

profile view aerial view

4. Simulate the effects of summer and winter wind wave action on the beach.

   a) Begin by simulating winter waves. Turn the fan to high speed to generate short period wind waves which reach the beach.

   b) Describe what occurs to the waves and to the beach as the wind waves reach shore.

   c) After about 5 minutes, turn off the fan. Make 'after' sketches of the aerial and profile views of the beach. Include in these sketches the waterline and toothpick locations. Use arrows to indicate the direction of sand movement.

   d) Compare 'after' sketches with 'before' sketches. Be prepared to describe changes in the beach.

   e) Repeat procedures b,c, and d, this time simulating summer waves. Begin again with a smoothly sloping beach. Turn fan on lowest speed.

> **Note:**
> If you are unable to vary the fan speed enough to generate noticeably different summer and winter waves, use a wooden paddle to generate summer waves. Rock it about once per second for summer waves and more energetically (about three times per second) for winter waves.

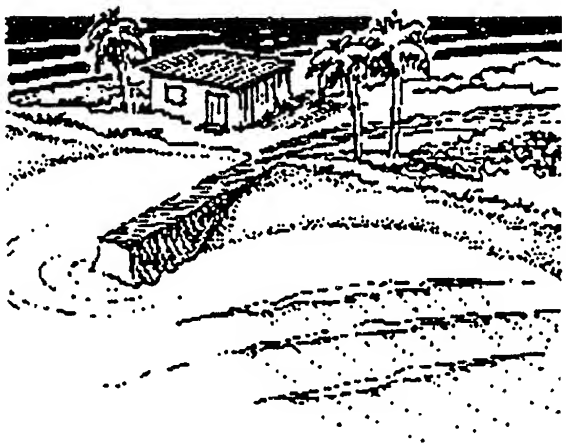
5. Simulate wave interactions on the leeward and windward coasts of an island.

   a) Using the tank, place sand about 2/3 way down the length of the tank to form an island. The island should be about 5 cm higher than the waterline and narrow enough so that water can flow freely around all sides. Mark the shoreline with toothpicks.

   b) Make accurate profile and aerial sketches of the island. Show its height, width, and the slopes of the beaches.

   c) Turn the electric fan on high and adjust it to generate wind waves which travel to the island.

   d) After 5 minutes, turn off the fan. Observe and sketch the effects of wind waves on the windward and leeward coasts of the island. The windward beach is on the side facing the prevailing winds and the waves they form. The leeward beach is on the opposite side of the island, or the side protected from the prevailing wind. A prevailing wind is the wind that is most common to an area.



Topic C: Marine Life

The flora and fauna of the sea is an inseparable aspect of the life of the Pacific Island people. The wide variety of marine animals and plants ranging from the gigantic whales, sharks and dugong to the microscopic zooplankton, from the broad-leafed fronds of the reefs to the small algae on coral, all make their presence felt either directly or indirectly. Fish and seaweeds are eaten; some plants (particularly the beach plants, e.g. Gueguesina (Samoa) are important as herbal medicine; while other sea creatures play a valuable role in the physical build-up of the islands e.g. corals building up atolls.

However, over the last few years there has been an increasing threat to marine life mainly due to the destructive action of man, e.g. destruction from excavations, over-exploitation of fishing for commercial purposes, collection of shells for the tourist industry, collection of shellfish by villagers due to pressure on food supply as a result of increasing population. The study of marine flora and fauna by children is thus very important if these natural resources are to be sustained for use also by future generations of people.

When examining the topic of Marine Life, children will be learning the concepts of:

- ❑ adaptations
- ❑ classification
- ❑ structure
- ❑ endangered species
- ❑ food chains
- ❑ predator/prey relationship
- ❑ producers/consumers/decomposers, and
- ❑ camouflage

Here are descriptions of some common marine life:

Anemones: are like plants in that they are fixed in one place. They have a structure similar to that of coral polyps and like polyps they sting and paralyse their prey.

Worms: ribbon worms, bristle worms and flat worms live on the undersides of rocks at low tide.

Molluscs: have a single foot by which they move along. They often have shells (bi-valves have a 2-hinged shell). They also have a radula or tongue which they use to gather food.

Chitons: are also molluscs which have 8 overlapping plates and are herbivores which graze on algae at night.

Crustaceans: crabs, shrimps and crayfish - ghost crabs have eyes on long stalks; fiddler crabs have one long claw and one small claw in the front; hermit crabs live in borrowed homes.

Echinoderms: *echinos* means "spring" and *derm* means "skin". The parts of the bodies of many of the animals in this group are in 5's, e.g. sea stars have 5 arms.

Activity 1: Visit to the Sea Shore (Field Activity)

The aim of the visit should be to collect information so that a discussion can be held later (in the classroom) on the natural environment visited and the dangers (if any) that threaten it:

Material:

- ❑ Activity Sheet (See below).
- ❑ Sheet of plastic to serve as a temporary aquarium on the beach.
- ❑ Magnifying glass, if available.

Activity Sheet

What I saw on the seashore:

Is it a Plant or Animal?	Where was it?	What was it doing?
1. Sea weed		
2. Barnacles		
3. Tube worms		
4. Sea Cucumber		
5. Starfish		
6. Hermit Crab		
7. Rock Crab		
8. Mollusc		
9. Fish		
10. Bird		

Procedure:

1. If possible the teacher should visit the area beforehand and identify about 10 points of interest.

2. Prepare the children for the visit by drawing up a code of conduct, which should include safety rules and guidance concerning the care of the environment. For example:

   - ❑ look before disturbing;
   - ❑ return all plants and animals to their habitats after observing them;
   - ❑ replace any rocks which have been moved or turned over; and
   - ❑ make sure the children are aware of the dangers of rising tide and poisonous animals.

3. Arrange the visit for low tide and ask some parents to come along so that there is adequate supervision.

4. Draw up activity sheets before leaving the class.

5. Divide the class into groups and allot to each group a section of the seashore.

6. First let the children explore and then, on a given signal, ask them to collect their specimens, record on their activity sheets and place any particularly interesting specimens into the temporary aquarium (plastic sheet placed over a depression in the sand and held down with stones).

7. On returning to the classroom, one child from each group should report on its group's findings and an overall picture of life on the seashore can be developed and discussed.

Activity 2: Examining Marine Organisms (Field Trip)

Material:

- ❑ Plastic Sheet approximately 4ft x 4ft (for use as a temporary aquarium covering a depression in the sand and held down by rocks).
- ❑ Magnifying glass.

Procedure:

1. Check **Unit One: Teacher Training for Environmental Education** for some useful hints in preparing for a field trip.

2. Before leaving on the field trip, the class should have some understanding of what is meant by the terms:

   (i) classification
   (ii) adaptation
   (iii) camouflage
   (iv) predator/prey relationships
   (v) producers/consumers/decomposers
   (vi) mutualism (for more advanced classes)
   (vii) commensalism (for more advanced classes)

3. At the seashore, pupils should be asked to look for corals (several different types), anemones, marine worms, molluscs, barnacles, sea weed, crustaceans, echinoderms. The children should be asked to observe (note and draw) different organisms' behaviour and habitat. They should also look for signs of pollution - such as evidence of disturbance by people, tracks, litter, changes in plants, etc.

4. Very interesting organisms should be put in the temporary aquarium for more detailed observation.

5. Before leaving the area, check that no material is being taken from the shore unnecessarily. Empty shells and other non-living material may be taken but living things should **not** be removed. Check that all stones are turned back and leave the area as undisturbed as possible and free of litter.

6. When back in the classroom, discussion should revolve around what was observed and its relationship to the concepts outlined previously. For instance:

   - ❑ discuss what the class observed;
   - ❑ discuss the interrelationship between the organisms;
   - ❑ discuss the importance of maintaining a balance in nature;
   - ❑ discuss uses of marine life (ornaments, medicine, food); and
   - ❑ discuss food chain, food web, pyramid.

   Now encourage the class to write stories and poems and perhaps bring in a guest speaker from a nearby village. Finally, classify empty shells, e.g. number of parts (valves), habitat (sandy shore or rocky shore), feeding habits, colour, pattern, size (arrange one species in order of size), weight, and any other common properties that can be discovered.

Activity 3: Food from the Sea

Many coastal communities depend on the resources of the sea to provide an important part of their diet. This activity will allow students to gauge that importance for themselves.

Material:

- ❑ Pen
- ❑ Paper
- ❑ Clipboard (if available)

Procedure:

1. Visit the local landing place (or Fish Cooperative) as the fishermen come in with their catches. Alternatively, visit the local fish market.

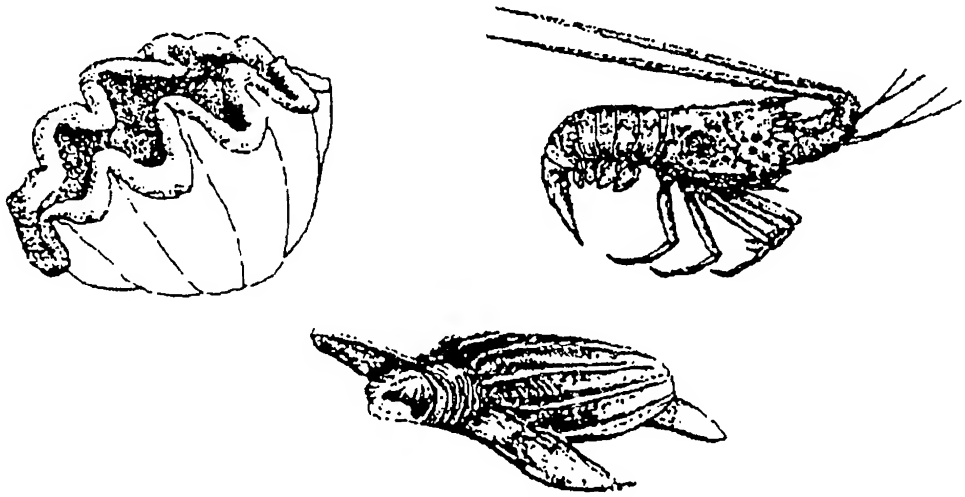
2. List all the different kinds of seafood brought in or available for sale. A similar list can be made by each child of the seafood eaten at home over a period of a week. If subsistence fisheries or gleaning by women and children are important, these also should be observed and recorded.

3. On the basis of the figures collected, make simple estimates of the amount of food produced locally from the sea, perhaps measured per kilmetre of coastline, on an annual basis. If the data is available, also determine the fishermen's catch per unit of effort (hours spent fishing per fisherman or per boat).

4. Compare the local catch or consumption of fresh seafood with that of imported seafood (canned, dried or frozen) using import statistics and/or the children's reports of home consumption.

5. Try to determine whether there is a move from local to imported seafood consumption. If there has been a change of seafood consumption, is it due to a change in the local resource (i.e. limited from overfishing or pollution) or to consumer preferences (better taste, or the ease of opening a can).

6. Discuss the results of the class study in terms of the management of the coastal marine environment.



Topic D: Coral Reefs

A coral reef is a complex system which consists of many other animals and plants as well as corals. It provides food and shelter for a greater variety of living things than most other natural areas in the world. Many marine plants and animals are too small to see with the naked eye. All reef plants are small compared with a forest but many like the sea grasses and some sea weeds, can be seen quite easily.

The total mass of plant material on the reef is very high, rivalling that of the rain forest. All the life on the reef depends on the plants. The plants are sometimes brown or red but they contain green chlorophyll as well and it is this which enables them to manufacture carbohydrates by photosynthesis. Many coral reef animals, such as clams, crabs, lobsters and fish, are important food items for people living in Pacific Islands.

Under the topic of Coral Reefs, we examine:

- ❑ types of coral,
- ❑ structure of coral,
- ❑ how coral reefs grow,
- ❑ types of coral reefs,
- ❑ the coral reef ecosystem,
- ❑ diversity of life on the coral reef,
- ❑ the importance of coral reefs and potential for damage.

The South Pacific Regional Environment Programme (SPREP) has developed a Coral Reef Kit which contains a useful Coral Reef Handbook (suitable for schools), a coral reef slide set, posters, stickers, colouring sheets and student activity sheets. These can be obtained (free of charge to schools within the region) from:

The Director
South Pacific Regional Environment Programme (SPREP)
P.O. Box 240
APIA
Western Samoa

Activity 1: Excursion to the Reef

Material:

- ❑ SPREP Coral Reef Handbook for class discussion before the excursion. (Valuable but, not essential if not available).

Procedure:

1. Check Unit One of this Manual, **Teacher Training for Environmental Education, Section 3, Field Trips** to assist in preparation for the excursion.

2. If possible, teachers should make a preliminary visit to the area to help develop a series of questions for the class to investigate.

3. Make sure that you have adequate supervision for the children and that they are aware of the dangers both from rising waters and from poisonous animals. Watch out for stone fish, cone shells, stinging coral, sea urchins and sea snakes. The latter can be extremely dangerous and children cannot be allowed to handle them. They should wear shoes and avoid coral cuts which can easily become infected.

4. Let the class work in groups, alloting a section of the reef to each group.

5. Ask the class to concentrate on a few aspects of the reef. Questions may be developed by the class in advance. It is a good idea for these questions to be written down.

Conditions that have led to the formation of the reef

6. Ask the children to look to see if they can tell the difference between live and dead coral.

7. Ask the children to investigate which conditions the living coral prefers (Coral only grows in salty, warm water). Have the children taste and feel the water.

8. Ask the children to note whether the type of coral varies with the depth of water or degree of exposure at low tide or the amount of wave movement.

9. Ask the children to note the amount of sunlight as coral only grows where there is sufficient light for the small plants that live within the polyps to manufacture food by photosynthesis.

10. Have the children note the colours of the living coral.

Reef sediment

11. Explain to the children that large areas of land surface are made up of dead coral and can provide us with a lot of information about the reef.

12. Have them look around the land near the sea for any clues about the reef. Look for broken bits of coral, sea shells, broken bits of marine plants and animals, pebbles, sand and volcanic material, e.g., pumice. Take a jar full back to the classroom for closer examination.

13. Ask the children to note whether the land surface changes further away from the sea.

Activity 2: Coral Reef Slide Set

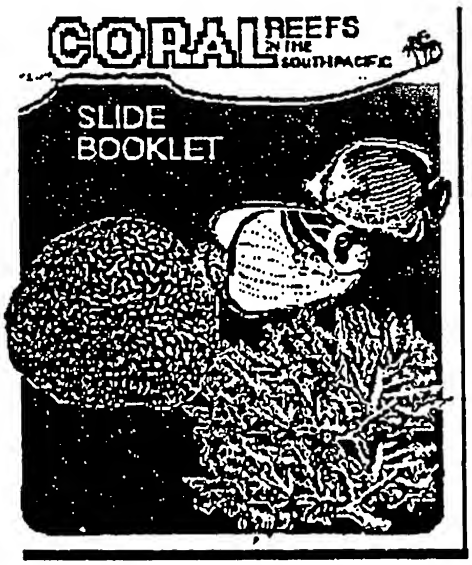
Material:

- ❑ A Coral Reef Slide set (with a booklet containing useful background information for the teacher) is available free of charge from the:

  Information and Publications Officer
  South Pacific Regional Environment Programme (SPREP)
  P.O. Box 240
  APIA, Western Samoa.

Procedure:

1. The teacher should read the background information contained in the slide set booklet beforehand.
2. Show the slides to the children.
3. Follow through with class discussions on:
   (i) how reefs are formed;
   (ii) the three main types of coral reefs;
   (iii) problems of pollution and its effects on reefs;
   (iv) possible ways the tourist industry could harm the reefs; and
   (v) the unique adaptation of reef life.



Activity 3: Coral Reef Fact Sheet

Material:

- ❑ The *Coral Reef Fact Sheet* - No. 3 - is available free of charge from the:

  Information and Publications Officer
  South Pacific Regional Environment Programme (SPREP)
  P.O. Box 240
  APIA, Western Samoa.

Procedure:

1. Read the Fact Sheet and use it to describe to your class:

   (i) how Coral Reefs are formed;

   (ii) three main types of reefs;

   (iii) an awareness of effects on the coral reef of:

   (a) Pesticides,
   (b) Siltation,
   (c) Oil Pollution,
   (d) Over-fishing,
   (e) Dredging,
   (f) Dynamite and poison,
   (g) Sewage Pollution,
   (h) Nuclear Wastes, and
   (i) Tourism.

Activity 4: Coral Reef Colouring Sheet

Material:

- Coral Reef Colouring Sheets, printed in blocks of 30 pages, are available free of charge from:

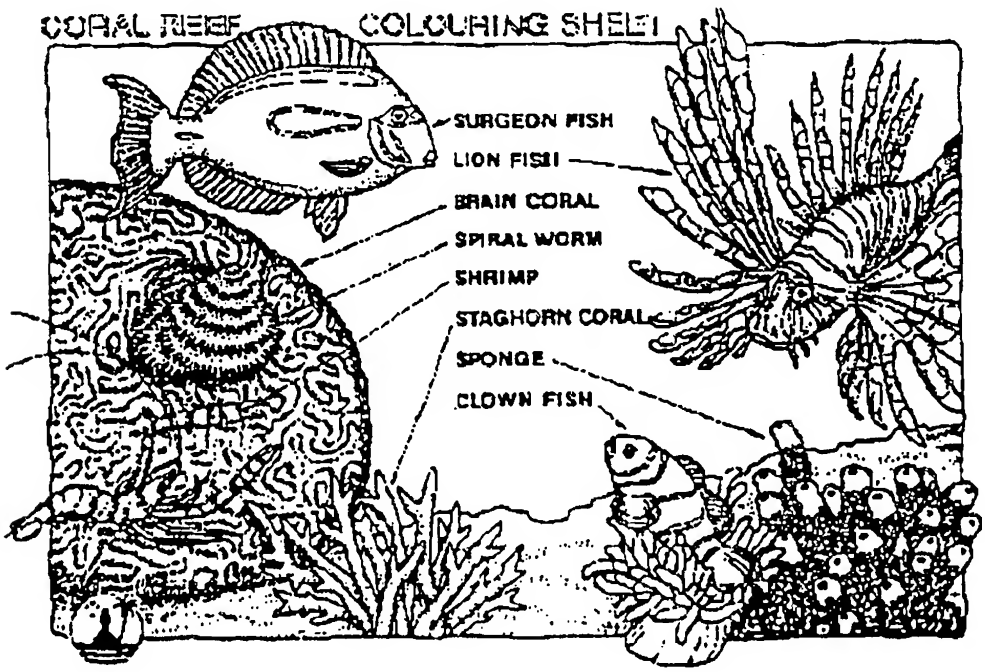
  Information and Publications Officer
  South Pacific Regional Environment Programme (SPREP)
  P.O. Box 240
  APIA, Western Samoa.

Procedure:

1. Distribute one Colouring Sheet to each child.

   Very young children could be requested to merely colour in the sheet, whilst older students could be asked to find the local names for the reef life mentioned on the sheet.

3. Older students could also write a story about the inter-related nature of the reef life shown. Although not necessary for this exercise, a useful background document is the Coral Reef booklet available from SPREP.



Activity 5: Coral Reef Handbook Comprehension

Material:

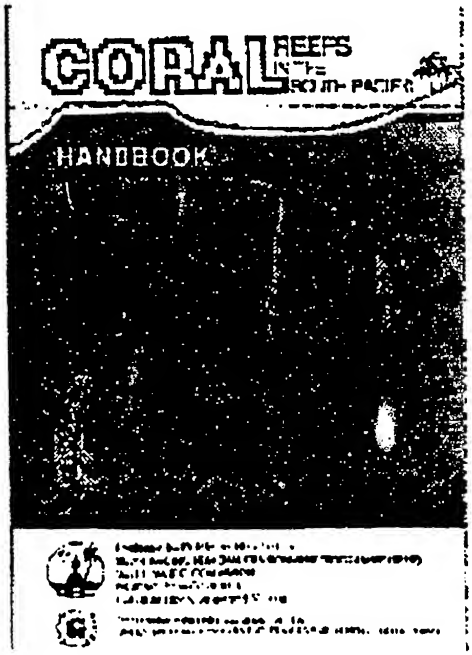
- A *Coral Reef Handbook* is available free of charge to South Pacific schools as part of a Coral Reef Kit from the:

  Information and Publications Officer
  South Pacific Regional Environment Programme (SPREP)
  P.O. Box 240
  APIA, Western Samoa.

Procedure:

1. High School students, after reading the text, should turn to page 37 and answer the level one questions and page 38 for the more difficult, level two questions.

2. This activity is dependent on you having enough copies of the Coral Reef Handbook for your class. Multiple copies are freely available from SPREP but should insufficient books not be available, this could be undertaken as a group activity.



Activity 6: Coral Reef Chemistry Exercise

This activity is suitable for older students and aims to discover what chemicals are present in the skeletons of hard corals. This activity, although outlined below, is also available from SPREP as Student Exercise No. 1 in printed blocks of 30 sheets.

Material:

- ❑ dead coral pieces (from the beach)
- ❑ concentrated hydrochloric acid
- ❑ test tube
- ❑ bunsen burner
- ❑ a piece of filter paper.

Procedure:

1. Crush the coral pieces and rinse in fresh water. Allow the coral to drain dry.

2. Add a few drops of hydrochloric acid to some crushed dry coral in a test tube.

3. Hold a burning match over the mouth of the test tube. Carbon dioxide is a colourless, odourless gas which puts out a burning match.

4. Dip a rolled up filter paper into the remaining acid coral paste. Hold the paper in a clamp and place the moist end into the flame of the bunsen burner. A dark red flame suggests the presence of calcium.

5. It will be shown that the coral rock consists mainly of calcium carbonate which reacts with acid to give carbon dioxide gas and leaves calcium chloride as a paste.

$$CaC0_3 + 2\,HCl \longrightarrow CO_2 + CaCl_2 + H_20$$

Unit Three:

Pollution

Introduction

We can think of **pollution** as a deterioration in the quality of our environment as a result of human activities. Put simply, pollution is the way in which we spoil our surroundings. Pollution is an increasing problem for many island nations as populations grow and as more sophisticiated life styles are adopted. However, it should not be thought that pollution is a process associated only with industrial societies. Even in traditional Pacific island villages, pollution is not difficult to find.

Components in Unit Three

Learning/teaching activities in this Unit have been prepared for the following topics:

A. Land pollution
B. Water pollution
C. Air pollution
D. Nuclear pollution
E. Integrated pollution

Pollution can effect our **land**, our **air**, and our **water**. Some activities affect all three. Although pollution in the South Pacific region is relatively small compared to the more industrialised countries of the world, nevertheless there is an increasing recognition of the potential for significant environmental degradation of our islands.

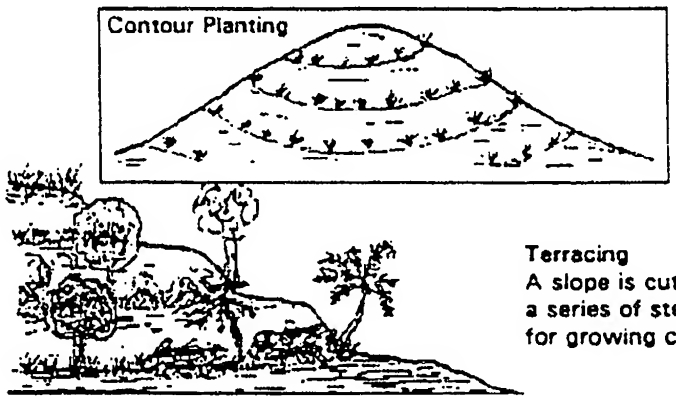
It is important to realise that pollution not only affects the environment of any one organism but also the ecosystem of which it is a part. For example, if toxic wastes are dumped into the water around the reef, the coral could die. The other organisms living with, or on, the coral (including fish and humans) would be adversely affected.

Thus the **interrelationships** between the parts of the environment and the organisms in it, must always be kept in mind.

Some of the activities which have been identified by South Pacific governments and administrations as causing pollution in the region are: **agricultural practices**, often involving extensive use of pesticides; **mineral extraction**, often resulting in considerable erosion and siltation; **forestry practices** which all too often involve cutting on steep slopes with resultant soil erosion and eventual siltation of rivers and coastal areas; **waste disposal**, both of a domestic and industrial nature, some of which includes toxic and hazardous substances; and **urbanisation**, particularly development of coastal areas resulting in destruction of mangrove and reef resources for landfill and road building materials. Many of these activities are interrelated and can result in pollution of our land, water and air.

Topic A: Land Pollution

Agriculture is a major human activity in the South Pacific but, unfortunately some agricultural practices either pollute the land or end up polluting the surrounding water or air. For instance, clearing land on steep slopes for growing crops or for forestry, particularly on a large scale can cause soil erosion or even land slips. Without the roots of trees to hold the earth together, the soil is washed away particularly in high rainfall areas. It is usually the rich top layer that is lost, making the soil less fertile and making it difficult for crops to grow well. Soil that is washed away can also end up polluting the surrounding reefs and sea. This soil erosion can, however, be avoided by sensible management practices including planting crops along contours around the hill slope, terracing and leaving belts of trees across the land



Terracing
A slope is cut into a series of steps for growing crops

A leaflet outlining a case study of deforestation in Wallis and Futuna (*South Pacific Case Study No. 2*) is available from the South Pacific Regional Environment Programme (SPREP), P.O. Box 240, APIA, Western Samoa.

Pesticide use can create a serious agricultural problem. Pesticides are poisons which are used to kill or control pests; those used to kill weeds are called herbicides and those used to kill insects are called insecticides.

Traditional agricultural practices such as slash and burn, which allows the soil to recover naturally by leaving the soil unplanted for many years, needs no expensive chemical inputs. Modern agricultural practices, however, need chemical products for almost every activity. Unfortunately, pesticides that can be harmful to nature's pests can also be dangerous to us and other useful organisms. Problems can also occur when pesticides used on the land are washed away by rain into rivers and coastal waters. These pollute the water and are particularly harmful to young or larval stages of marine organisms.

One example of a pesticide used widely within the South Pacific region is DDT, a well-known cumulative insecticide which passes along food chains in fatty tissues and becomes concentrated in the final consumer. It is banned in many countries, but it can still be found in our Pacific islands, particularly in areas where it is needed to kill malaria-carrying mosquitoes. Until an equally effective economic substitute is developed, the use of DDT is likely to continue in the South Pacific.

There is concern that Pacific islands could become "dumping" markets for pesticides banned in other countries especially as the handling, transportation, storage and disposal of some highly toxic substances is not always tightly regulated and controlled. Fortunately there is a growing awareness of the need for greater monitoring of the environmental effects of agricultural chemicals and for more stringent controls on the importation of these products, particularly given the fragility of some South Pacific island ecosystems.

Mining in the South Pacific region often involves earth disturbance on a very large scale with the associated problems of mine waste disposal and seepage of contaminants into water systems. Nauru presents a prime example of an island which has sacrified almost everything to its mining activities, in this case Phosphate. So devastated is the surface of the island that scientists estimate it will be unfit for any form of agriculture for centuries. Increasingly governments are recognising that if they choose to boost their economies by mining, they must plan ahead carefully and either find a means of extracting their minerals which does not disturb the island's surface, or abandon not only their traditional life style, but maybe even their island itself. They are recognising that the consequences of mining activities must be weighed and future outcomes studied before decisions relating to these activities are made.

> **Case Study Leaflets** on *The Effects of Mining on the Environment of New Caledonia* and *The Effects of Phosphate Mining in the South Pacific* (South Pacific Case Study Number 1 and Number 4 respectively) are available in multiple copies from the South Pacific Regional Environment Programme (SPREP), P.O Box 240, Apia, Western Samoa.

Inadequate sewage and other waste disposal facilities in rural and urban areas has resulted in contamination of fresh water supplies from rivers and ground-water sources. Raw sewage has a high bacterial content and can contain disease germs such as typhoid and cholera, outbreaks of the latter having occurred in two island countries of the South Pacific during 1990. The installation of sewage treatment plants and solid waste disposal facilities in towns, hotel developments and places where populations are concentrated is an urgent need of many island countries. Increasingly it is becoming a requirement of government planning departments that adequate sewage treatment be included in development proposals. Sewage contamination is microscopic and often not directly visible but other solid wastes like beer cans, bottles, car tyres and plastics are an eyesore in many areas. Plastic bags may be cheap and convenient but when they end up in the environment not only are they unsightly, but they can cause death for an organism. For example, turtles, seals, fish and birds can become trapped in, or be choked by, an assortment of plastic waste.

Many of these wastes are unnecessary and represent transplanted cultural practices. The coconut leaf or pandanus fibre basket is an article of skill and worth and has the major advantage of being **biodegradable**. Given the severe problem of solid waste disposal on small islands, the limitation and use of appropriate packaging materials should be considered whenever possible. Perhaps as the coconut tree grows so prolifically on many islands, encouragement could be given to teaching the variety of traditional uses of this tree, and other skills as a possible proven means of reducing non-degradable wastes.

Urbanisation - the development of shopping centres. housing and industrial areas - is increasing rapidly on some islands. It needs land clear of its natural vegetation, often resulting in the destruction of ecosystems. All too often it is the mangrove area that is filled in for land and the coral resources that are used as road surfacing and building materials. Yet both mangroves and coral reefs play an important role in ensuring that the island environment is kept intact.

A clean and a polluted beach

Activity 1: Pesticides

Material:

- ❑ a collection of pesticide containers
- ❑ information about the use of pesticides

  (e.g., the *Pesticide Fact Sheet* available from the South Pacific Regional Environment Programme (SPREP), P.O. Box 240, Apia, Wesstern Samoa).

Procedure:

1. Ask the class:
   - ○ what are pesticides?
   - ○ why are pesticides used?
   - ○ what would happen if pesticides were not used?
   - ○ what alternatives are there to using pesticides?

2. Organise a class survey of pesticides available and used in the area. This could be a survey of shops or a survey of farmers in the region or a student survey of pesticides used in the home.

3. Before the class goes out to collect the information, prepare a table for them to write down their results. Here is one suggestion:

List of Pesticides Available

Name	Use	Users	Country of Origin	Danger Level			Warning	Cost
				High	Medium	Low		

4. You could ask the class to find out what other chemicals are used for agriculture and the purpose of these.

5. Put all the results together possibly in a wall display using the same format as the table above, adding a column for the number of times a particular agricultural chemical was found.

6. Discuss with the class the use of chemicals for agriculture. Try to look at the benefits and the disadvantages of using chemicals. Refer in particular to the potential disruption to the ecosystems caused by pesticide use.

Activity 2: Litter

Material:

- ❑ A large wall plan of the school ground
- ❑ A large wall histogram (bar chart)

Procedure:

1. Divide the class into groups each to survey a particular area of the school ground. Each student then draws a plan of their respective area to take with him/her into the school ground.

2. All students go out and collect litter in their assigned area noting down on their plan exactly where each item of litter was found e.g. under a coconut tree, near a path, near a seat, etc. Assign symbols to each kind of litter.

Example: Lolly wrapper
Paper 
Plastic 
Cans 

3. Each group should have a plan of their area with the litter marked on it. Transfer this information onto the class map.

4. Ask students to make a histogram/bar chart showing the number of each type of litter in their area.

5. Transfer this onto a large wall histogram. (This activity could be repeated either every day for a week or once a week for four/five weeks.) Student groups could stay in the same area or move to a different area of the school ground on each survey.

6. Discuss the practices that lead to littering. Ask students to suggest some solutions.

7. Show the Principal the results of the litter survey. Suggest plans of action about possibly reducing the litter pollution of the School ground.

> **Note:** It is possible to extend this activity to include a village.

Activity 3: Waste Disposal

Material:

- ❑ Wall histogram

Procedure:

1. Ask each child in the class to make a record of what his/her family throws away in one week. They should sort the waste into types, like glass bottles, tins, paper, plastic wrappers, plastic containers, waste food.

2. The children should give weights (in grams) to each type. If no balances are available these can be estimated, or counted.

3. Plot a histogram of the findings on the whole class data. Discuss the results and their implications for waste disposal as a potential and growing problem. Aspects of health should be emphasised.

4. Ask the children where this waste goes? What problems are associated with its collection and storage? Also discuss possible ways of reducing the throw-away waste at home. Lead pupil discussion onto methods of recycling, re-use and traditional ways of packing food.

5. Write a conversation between two cockroaches about how they love it when humans pollute the environment.

Activity 4: Land Pollution (Field Trip)

Material:

- ❑ Worksheet (see example below).
- ❑ Pencil

Procedure:

1. Identify two areas of land that are fairly similar, one of which is obviously polluted but the other is not.

2. Prepare the class for this short field trip with a worksheet. The following is one suggestion:

Pollution Worksheet

Location	Pollutants	Cause	Seriousness	Possible Action or Solution

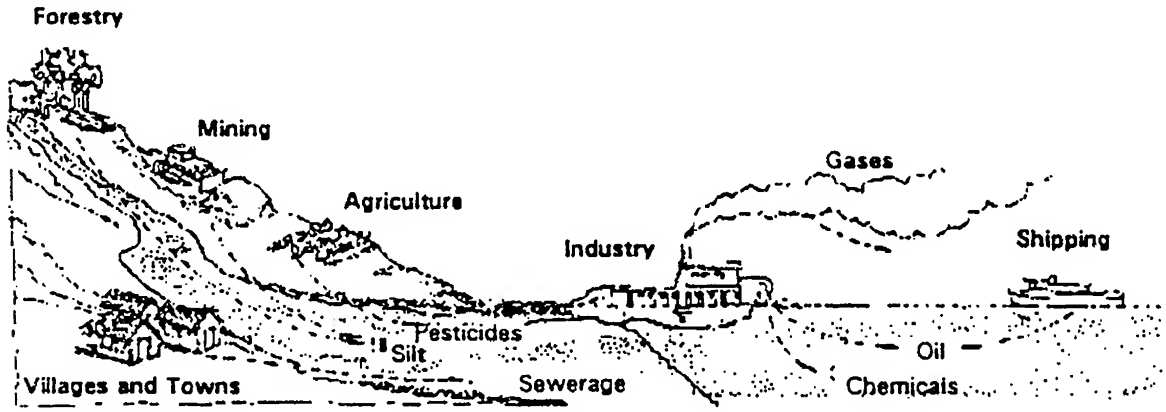
3. Divide the class into groups. Each group should make observations and record them on the worksheet.

4. Discuss the pollution aspects on a whole class basis, with a view to any appropriate action. Perhaps require the children to carry out this action.

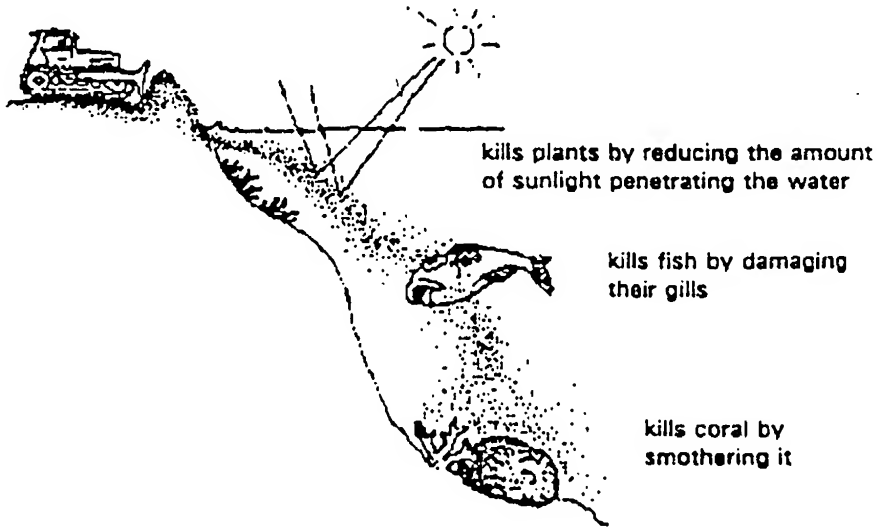
5. Over a period of a few days, have the children decorate a bulletin board to look like a polluted area. Encourage them to be imaginative - use real rubbish, or cut-out shapes or magazine cut-outs. Don't forget the organisms - how would they feel? How would they look? After this is completed, get the class to clean up the polluted area by removing the rubbish.

Topic B: Water Pollution

Water pollution occurs at varying levels and is often the result of activities undertaken on the land. Some pollutants in seawater may only be measured and their effects confirmed by close scientific examination. Other more concentrated pollutants, may be immediately obvious, devastating the environment, causing the death of marine species and perhaps the people eating them. The limited exchange of water with the sea in the lagoons contained by the barrier reefs which surround many Pacific Islands, often results in the build-up of dangerously high concentrations of pollutants.

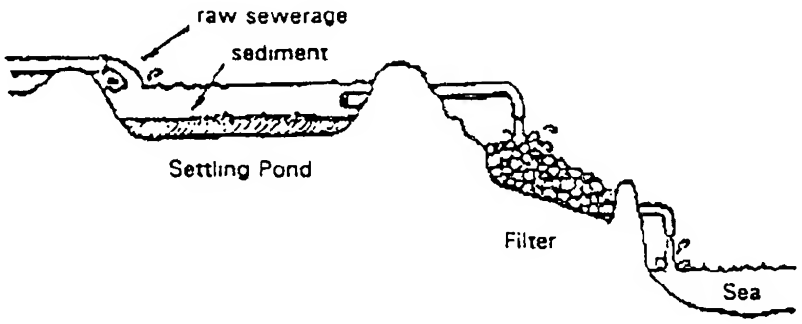


Soil erosion from agricultural, forestry or mining practices causes siltation in rivers and along the coastal regions. As pressure for more agricultural land causes deforestation in upland areas and destabilised soil is eroded, the sediment loadings of rivers increase. This sediment is then carried into the sea. This is most evident after heavy rainfall when the water becomes cloudy with soil particles. Water clarity (clear water) is crucial to coral life. The algae living in the coral need light to make their food which is not possible in cloudy water. Extensive island soil erosion usually means death for the reef coral and loss of habitat for a host of marine organisms. Planners are increasingly aware of the need to consider that economic gains made as a result of forest development, may mean losses to other areas, especially the reefs.

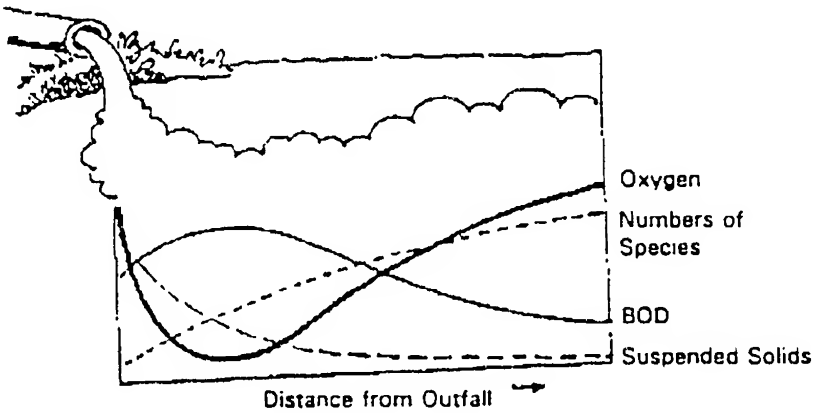


Pesticides used for agriculture also end up in the rivers and the sea, problems occurring when pesticides are washed away by rain. Some pesticides are very stable, that is, they remain unchanged in the environment for a long time, and many of these can be very harmful to the young or larval stages of marine species.

Development in coastal regions often has an adverse impact on the environment. In an attempt to gain more valuable waterfront land, mangroves are often "reclaimed" by cutting down the trees and filling in the land for housing. The construction of wharfs and breakwaters will interfere with water currents, the formation of beaches and the natural movement of fish. The most common type of pollution in areas of high population is caused by *sewerage*, human faeces and urine in the water, which is released into the sea. Sewerage can be treated (as shown in the diagram below) but this is expensive and requires areas of land for building ponds. If sewerage is held in large ponds, much organic material will settle out as sediment. Passing the remaining liquid through gravel filter beds may remove other organic matter in the liquid.



Whether treated or untreated, sewerage released into the sea will tend to increase the quality of nutrients - particulrly nittrates (NO3) and phosphates (PO4) - in the surrounding water. This will encourage the growth of bacteria which use much of the dissolved oxygen. In fact, the degree of pollution may be measured by the consumption of oxygen, or *biological oxygen demand* (BOD). The high nutrient levels encourage the growth of marine plants and phytoplankton - this plant material eventually decomposes and uses up even more oxygen. The high abundance (or blooms) of phytoplankton may turn the polluted water green. Sometimes, the growth of poisonous plant material is encouraged and some people believe that the blooms of the phytoplankton could be a possible cause of *ciguatera* (fish poisoning).



The graph above shows what is likely to happen at various distances from a sewer outlet pipe. Close to the outlet there is a large amount of bacteria and the oxygen is used up (the water has a high BOD). Very few marine animals can live in such polluted water. At increasing distances away from the outfall the oxygen and the number of different species of animals returns to normal levels.

Sewage may also carry other pollutants including detergents which may cause foaming and reduce the ability of water to hold dissolved oxygen. Levels of some bacteria may also be high enough to be a risk to health, particularly to swimmers and those eating animals caught in the polluted water.

There are very few heavily industrialised towns in Pacific Islands. Nevertheless several types of industries including sugarmills, engineering plants, fish and fruit processors discharge their wastes directly into coastal waters. Serious industrial pollutants are cyanide and metals such as copper, zinc, lead and mercury. Some of these metals are particularly dangerous because they are *cumulative* - that is, even small amounts in water will, over a long period, become more concentrated in the flesh of edible marine animals. Larger carnivorous fish, may gain even higher concentrations by **biomagnification** and become extremely toxic to human beings.

Oil, although less toxic, is a serious pollutant released by certain shore installations and by ships. Oil forms a thin film on the surface of the water which may cover and kill coral and other intertidal animals attached to rocks.

The Pacific Ocean, because of its huge size, has been regarded as a convenient area for **dumping the toxic and hazardous wastes** brought to the South Pacific region by the more industrially developed countries. Of particular concern is nuclear waste. It is a tempting solution for these countries to get rid of such dangerous waste by dumping it far out to sea, this practice generally being very hard to control. Pacific Islanders and their governments, however, have had some success in their efforts to prevent dumping of such wastes in the Pacific Ocean by negotiation of international treaties such as the *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (the SPREP Convention).*

Activity 1: Water Pollution Survey

Material:

- ❑ Worksheets or exercise books.
- ❑ Pencils.

Procedure:

1. Select a couple of sites for a brief class survey of water pollution. Those should be fairly near to school and show signs of pollution.

2. Prepare a worksheet (as shown below) or have the students copy down the following ready for use in the field:

Water Pollution Survey		
	Responses/Observations	
	Site 1	**Site 2**
How does the water look?		
How can you tell that it is polluted?		
How does the water feel?		
How much animal life is there?		
How does the weed at the side feel to touch?		
What does the air around the water smell like?		
Would you like to swim in this pool?		

3. Organise the students into groups and explain what they should do. Remind them to be careful not to disturb the area they are observing. Then proceed out into the field.

4. On returning to the classroom, discuss the students' findings.

5. Pretend you are a (fish, bird, coral polyp etc.) living in a habitat which has been polluted by humans. What do you see, how do you feel, what will you do? (The children could be asked to write this as a brief story).

Activity 2: Water Clarity

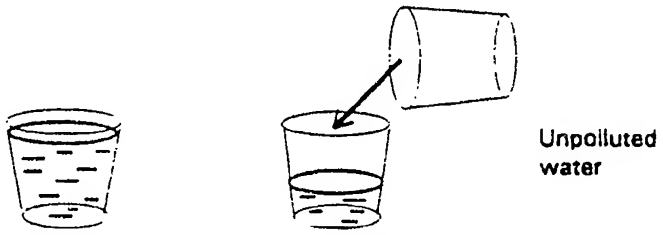
Material:

- ❑ Several jars
- ❑ Clean water
- ❑ Polluted water samples

Procedure:

1. Collect a range of water samples from different places e.g. lagoon, stream, river, ponds, near a factory, sewage, hotel outlets or a dump. (This could be a class field activity if a range of unpolluted and polluted water is convenient to the school).

2. Take one of the most polluted samples and dilute it by half.



   Then take the 1/2 diluted sample and further dilute this by half again. (In the end only a quarter of this will be the original water sample). Repeat this dilution once again to only 1/8th of the original sample. You should then have four jars, one of the original sample and three different dilutions.

3. Repeat the process so that each original sample has this range of dilutions. The class can help you do this.

4. Together with the class compare each sample and its dilutions. Particularly note the clarity and stress its importance to ecosystems in water environments. This could be done by groups of students each taking one sample and its dilutions.

5. Compare the water taken from the different sites. Encourage students' comments on:

   - ❑ the effect of this pollution on the organisms at the sites,
   - ❑ the sources of this pollution,
   - ❑ possible measures to stop the pollution.

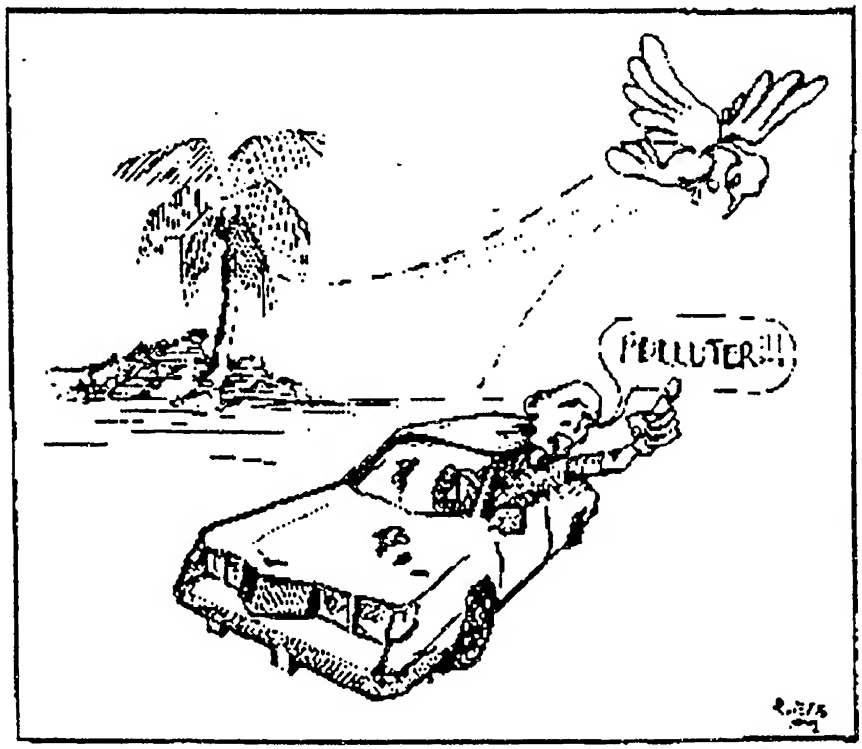
   Again this can be done by student groups reporting back to the whole class followed by a class discussion.

Topic C: Air Pollution

Most villages throughout the Pacific cook over wood fires, often inside and without adequate ventilation. The chimney has still not been adopted as a simple method of removing tar laden fumes in many housing situations; efficient wood burning stoves are rarely used. Consequently bronchial diseases, asthma and eye conditions are prevalent.

The now more common use of cars has led to exhaust fume pollution. These fumes are sometimes soot laden, particularly when carburettors or fuel injectors for diesel engines are not properly set for complete combustion. The truck or bus chugging up a hill belching black fumes would result in prosecution of the inconsiderate owner in many countries. Even well adjusted engines still produce noxious fumes like carbon monoxide which poison the haemoglobin in our blood, and nitrogen oxides which are carcinogenic (cancer causing).

Often such fumes contain heavy metals such as lead, copper and mercury which poison our body enzymes and those of other organisms too. Many countries have forced through legislation to ensure the use of lead-free petrol. It is a little more expensive but makes the environment much more pleasant and less dangerous to health.

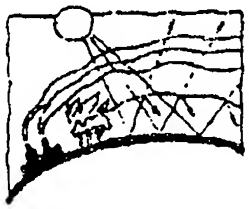


Domestic rubbish is a major problem in the islands. Overspilling dumps are sometimes burnt to reduce their size and eliminate pests. However, much of this rubbish contains plastics e.g. furniture and food packaging which produce highly toxic fumes when burned.

Greenhouse Effect

Our tropical Pacific islands have hot climates and extensive coastal development. A possible increase in atmospheric temperature and a potential rise in sea-level, as a result of the 'greenhouse' effect is cause for considerable concern.

A greenhouse is a small house made of glass which traps heat from the sun, and is used in cold climates to grow warm-climate plants. The 'greenhouse' analogy is used to explain what could be happening on a much larger scale to the earth. Some gases, mainly carbon dioxide, which appear to be increasing in quantity in the earth's atmosphere, may act in the same way as the glass in a greenhouse.



Some gases, mainly carbon dioxide, which appear to be increasing in quantity in the earth's atmosphere, may act in the same way as the glass in a greenhouse.

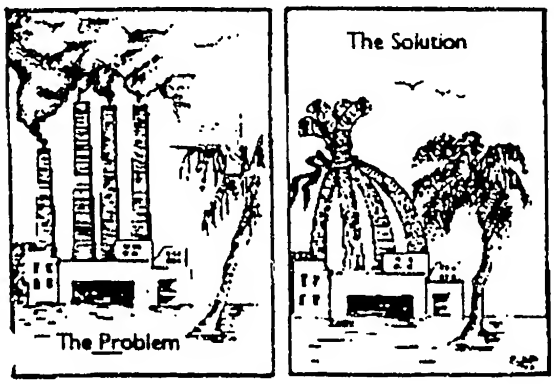
Heat from the sun reaches the earth's surface but it is prevented from escaping by a blanket of carbon dioxide. The greater the amount of this gas in the air, the greater is the proportion of heat trapped.

The main contribution to high carbon dioxide levels in the atmosphere is from burning forests and grassland and particularly fossil fuels such as coal and oil.

If the world's temperature is raised by the greenhouse-effect, the results could be disastrous. The volume of sea water in the oceans would expand with higher temperatures and melting ice in Antarctica could add to the volume. If average world temperatures increase by from 1.5° to 4.5°C over the next 50 years, sea-levels could rise by from 20 cm. to 140 cm. The rise would be too rapid to allow the growth of coral to maintain reefs at sea-level and many low-lying coral islands could be covered. This could mean the disappearance of whole nations e.g. Kiribati, Tuvalu or the most productive and populated parts of countries on the flat low-lying coastal regions.

Although the greenhouse-effect can be blamed on the disproportionate use of fossil fuels by industrial countries, it is a global problem. There is an urgent need to press for the wise use of fossil fuels by all countries of the world.

Depleting the Ozone Layer



Yet another atmospheric problem is the depletion of the ozone layer. The ozone layer in the upper atmosphere normally filters sunlight to protect us from more harmful radiation such as ultra-violet (UV) light. Scientists have detected a 'hole' in the ozone layer located over Antarctica. This gap seems to be growing. Increases in cancer-related conditions can be expected from this development. The scientists blame aerosol cans containing fluorocarbons for this serious development. Identifying and banning the use of such aerosols is thus a high priority.

Activity 1: Household Fuel

Material:

- ❑ Samples of local wood fuels
- ❑ Test tubes or small tins
- ❑ Heater e.g. bunsen burner or small stove.

Procedure:

1. Introduce this lesson by asking students about fuels used at home:

   - ❑ which types are used most?
   - ❑ where do they come from?
   - ❑ how much is used?
   - ❑ what effect does this have on the local environment?

2. Organise a practical investigation of the fumes given off by burning wood. This may be best done by splitting the class into groups who can work on one or two wood samples. (Alternatively a demonstration with student helpers of all the wood samples in front of the whole class could give the students the opportunity to observe a wider range of samples.)

3. For each sample, put a few pieces of wood in a test tube or tin and heat it.

4. The class should observe, looking closely and smelling, what happens to the wood and the inside of the container whilst heating. After cooling the containers should be examined again. (Heating wood drives off liquids and gases which condense on cooling. The tars in wood are particularly damaging to human health.) Comparisons of wet and dry wood could also be included.

5. Discuss the results with the class, and ask these questions:

   - ❑ which woods produce less fumes and tar?
   - ❑ what quantities of fumes and tar are produced by the most commonly used woods?
   - ❑ what are the health hazards?
   - ❑ what can be done to reduce this health hazard?

Activity 2: Burning Wood

Material:

- ❑ Samples of locally used fuel wood
- ❑ Chimneys made from tin cans.

Procedure:

1. Using the samples of fuel wood, make separate small fires. Place the tin can chimneys over the fire.

Tin cans slotted together to form a chimney

2. After a short period, say three minutes, make observations about the burning of that sample. These observations may be recorded in a table like the one below:

Wood	Dryness	Smoke (colour/thickness)	Amount of smoke	Smell	Burning efficiency
Burao					
etc.					

3. Clean the chimney and repeat the experiment with a different wood sample or a wet and dry sample of the same wood.

4. Compare the results of this experiment in the class.

   - ❑ Is any particular type of wood more popular than another?
   - ❑ Is any wood more convenient to use than another?
   - ❑ Is any wood environmentally better than another?

5. The students working in groups could investigate ways in which wood burning may be made more efficient.

Topic D: Nuclear Pollution

Background Information

In 1942 atomic fission of a uranium atom setting up a chain reaction of further fission was successfully carried out by a small group of scientists in Chicago, USA. Three years later, in an emergency situation due to World War II, the first atomic bomb was exploded in a desert in New Mexico. Three months later, Hiroshima was bombed and three days after that, Nagasaki. The war was over.

The end of World War II ushered in a new era. The Nuclear Age had begun. In January, 1946 Bikini Atoll, in the North-west sector of the Marshall Islands, was selected as the next site for nuclear testing. The residents were relocated to make way for nuclear experimentation which was claimed to be for the good of mankind. All this happened within a year of the nuclear destruction of Hiroshima and Nagasaki.

Operation Crossroads, as the series of atomic bombs tested at Bikini was called, officially started on July, 1946. The residents of Bikini Atoll, who were relocated to Rongerik Atoll, some 125 miles east, were now starting to experience hardships. For example, their new home was only 10.55 square miles, compared to Bikini's 2.3 square miles of land and a 299 square mile lagoon. Reports point out the fact that the vegetation to sustain an atoll lifestyle was 'very poor'. Malnutrition was reported after the first four months of occupying Rongerik. In September, 1946, 'Bravo', the biggest hydrogen bomb ever detonated by the United States went off on Bikini. About three hours after the blast, a white, snow-like ash began to fall on the 64 people living on Rongelap and the 18 Rongelapese on Ailinginae, about 100 miles east of Bikini. The Rongelap people received no official warning of the Bravo test, nor any notification of precautions to take to protect themselves from the fall out. The radioactive dust soon formed a layer on the island 2 inches deep. It turned the drinking water a brackish yellow and contaminated the food. By nightfall, as a result of their exposure, some people began to experience severe vomiting and diarrhoea. On nearby Rongerik, 28 United States Air Force and Army men along with the 16 Bikinians relocated to Rongerik were exposed. Radioactive ash fell on them. 'If you can imagine a snow storm in the middle of the Pacific, that's what it was like', said one Rongerik Air Force man. The residents of Rongelap were evacuated immediately, but of course, the damage had already been done.

It must be noted that some of the atomic bombs exploded at Bikini were of inestimable energy. For example, in 1951 'Dag' (April 8), 'Easy' (April 21), 'George' (May 9) and 'Item' (May 25) were of enormous power. 'Easy' was 47 kilotons but information on the others remains classified. The Bravo test was 'tens of millions of degrees' of intense heat, shooting upward at a rate of 300 miles an hour. Within ten minutes of the detonation the giant nuclear cloud reached more than 100,000 feet and was visible 275 miles away. Winds of several hundred miles per hour at the centre and 70 to 100 miles per hour at the blast's edge rocked the placid lagoon like a full scale typhoon. This blast was 15 megatons (15 thousand tons).

From the Bravo test, Utrik Atoll almost 275 miles to the East was the last to experience the radioactive fallout, which began late in the day and was described as 'mist-like'. Other islands that were affected by this same blast were: Ailinginaen, Ailuk, Bikar, Likiep, Jeno and Mejit.

There were other nuclear bombs tested in the Marshall Islands. On December 2, 1947, for example, the U.S. Navy announced that Enewetak Atoll, the north western most atoll of the Republic of the Marshall Islands, was to be the next site of nuclear testing. Twenty days after this announcement was made, the 145 people on Enewetak were relocated to uninhabitable Ujelong. This atoll's total land area is one-third of the 2.26 km2 of that of Enewetak. The Enewetak people were now to suffer the same undesirable experience their nearby neighbours of Bikini were currently experiencing.

The people of the abovementioned islands have far-reaching health problems. It was documented in 1958, that the rate of stillbirths and miscarriages was more than twice as high among the exposed Rongelapese women than among the unexposed Marshallese women. Other health-related problems considered by many to be associated with radiation, are very prevalent in these islands today. Compensation and justification of nuclear testing in the islands are still hotly-contested issues in the Marshalls.

Reports have cited other areas in the Pacific region where nuclear testing was recently carried out. French Polynesia is one of these places, in particular Mururoa atoll has been used by the French. Arguments have risen as to whether Kwagalein Atoll in the Marshall Islands is to become another testing site.

Equally as important as missile testing with its radiation fall-out, is the potential danger from the dumping and storage of nuclear wastes. Several places around the Pacific islands are suspected of being used by foreign "superpowers" as dumpsites. Additionally, sites have been proposed for examination to see how "feasible" they would be for storage of nuclear wastes.

The vast reaches and depths of the Pacific Ocean are tempting to nations faced with the insoluble problem of what to do with their nuclear wastes. There are those who balk at allowing nuclear armed or powered ships to enter their waters. It is possible that nuclear wastes may become a prime issue in the struggle of Pacific Islands to come to terms with the technology of today's world.

In the same way that small island nations often regard the vast Pacific ocean around them as an easy dumping ground for their undesirable wastes, the whole world has an eye on remote seas as convenient refuse grounds. We must change our attitudes to reduce the **creation of wastes** our planet cannot satisfactorily deal with.

> The learning / teaching activities on this topic tend to be rather theoretical but can raise important questions and help examine certain values. Under this topic the activities are concerned with the whole issue of nuclear pollution.

Activity 1: Nuclear Pollution in the Pacific

Material:

- ❑ The above "Background Information"

Procedure:

1. Read through the background information with the class. This should be supplemented by other information if available.

2. Discuss and pick out points from the background information to clarify this information.

3. Divide the class into teams and ask the questions in the following list (plus others of your own making). Alternatively this could be a comprehension exercise.

   (a) Name the main element used to make nuclear bombs.

   (b) Which two of the following Japanese cities were destroyed by atomic bombs: Tokyo - Kobe - Hiroshima - Kyoto - Nagasaki?

   (c) What are some of the immediate effects of radiation on the human body?

   (d) Name five countries having nuclear power today.

   (e) The effects of radioactivity on the human body can be treated and cured by medical science, drugs and hospital care: True? or False?

   (f) Radiation can affect future generations: True? or False?

   (g) Which Pacific Islands have been used for nuclear testing?

   (h) Which of the following countries conducted tests at Mururoa Atoll:
   England - USSR - France - Israel - Germany?

   (i) On which of the following island groups was America's first atomic bomb tested: Marshalls - Guam - Christmas - Hawaii?

   (j) The harmful effects of a nuclear explosion can last for hundreds of years: True? or False?

   (k) What are the long term harmful effects of radiation?

   (l) Which of the following diseases is associated with radiation:
   Malaria - Measles - Leukaemia (or Cancer) - Scabies?

   (m) The main nuclear waste disposal problem is that some radioactive wastes remain dangerous for a long time: True? or False?

(n) Radiation may cause abnormalities in unborn children by causing mutations: True? or False?

(o) Radioactivity is entirely man-made: True? or False?

(p) Nuclear fall-out helps the growth of mushrooms: True? or False?

(q) In what year were atomic bombs exploded on Hiroshima and Nagasaki:
1935 - 1940 - 1945 - 1950?

4. Go over with the class:

(a) the major health problems associated with nuclear radiation, and

(b) the difficulties of the situation that Pacific Islands find themselves in (this will touch on some aspects of international relations).

5. Set the students the following exercise:

Write an article for the newspaper describing the potential problems of nuclear testing for the people of the South Pacific. The following topics should be included:

- ❑ Impact on health
- ❑ Environmental damage
- ❑ Social problems.

Activity 2: Decisions about Nuclear Testing in the Pacific

Material:

- ❑ Background Information on *Nuclear Pollution* (above)

Procedure:

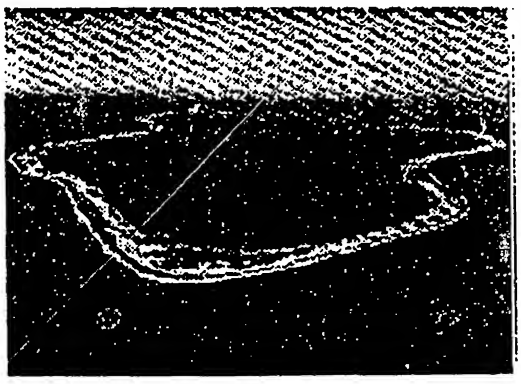
1. Introduce this activity by outlining the key events of nuclear testing in the Pacific.

2. Divide the class into small groups with a chairperson and note-recorder to discuss the following:

   (a) The health and social effects on the island people where nuclear testing has taken place.
   (b) What alternative courses of action were possible for the testers?
   (c) What could the island people have done about these events?
   (d) What should the Pacific nations do about the potential continuation of these tests?
   (e) How do you think the countries using the Pacific for testing would react to a ban on nuclear activity in the region?
   (f) List recommendations to the governments of the Pacific for possible courses of action regarding nuclear activity in their own countries.

3. The chairperson of each group should report their recommendations to the whole class.

4. Discuss the full list of recommendations with the whole class.



Mururoa Atoll

Topic E: Pollution in the Environment

Pollution in one part of the environment that can easily and quickly affect another part of the environment. This makes the consideration of pollution a complex matter. To any one problem there are many dimensions. Action in one part of the environment may have impact on many ecosystems that initially seem unrelated. Soil erosion from deforestation (see Land Pollution) is one example. Another is the use of DDT to kill malarial mosquitoes. It also affects other insect life and eventually finds its way into many food webs and accumulates in the bodies of various organisms such as birds.

The South Pacific governments and administrations are keen to develop and improve the standards and quality of life of the region's people. Buses, roads, electric power, sewerage systems and a clean water supply are not unrealistic expectations. To a greater or lesser extent, all of these benefits could affect the environmnent in a destructive way. The problem is how to have the most benefit with the least environmental destruction and pollution.

Traditional ways of building, farming and fishing by small populations have relatively few destructive effects on the environment. With increasing population growth and a trend towards a money-based or commercial economy, traditional ways are being lost. An island with a large population is under increasing pressure to provide employment and to over-exploit natural resources.

Development, however, can be balanced - in this way it is possible to retain what is best of the old ways and obtain the best of the new whilst ensuring that the environment is maintained in a form suitable for use by future generations. In other words, the natural resources can be developed on a sustainable basis.

Before any new development such as the building of a tourist resort or a factory takes place, many wise governments insist on an environmental impact statement. This involves a study and eventual report which could include:

- ❑ the reason for the development,
- ❑ a description of the proposed development,
- ❑ a description of the local environment and the likely effects of the development on it, and
- ❑ a description of alternative ways (if any) of meeting the same objectives with less damage to the environment.

The learning / teaching activities in this topic are case studies of development projects and a consideration of their environmental impact and some creative activities that could either be added to any pollution topic, or be used to round off this whole unit.

Activity 1: Development and the Environment

Material:

- ❑ Information on the cases as outlined below (worksheet or chalkboard)
- ❑ Wall Chart of the Island (or on the chalkboard)

Procedure:

1. Explain to the class that there are basically two options for development projects in which:

   - ❑ the development is uncontrolled and potentially destructive; or
   - ❑ the development is balanced, environmental alteration is minimal, and natural resources are protected or utilised wisely.

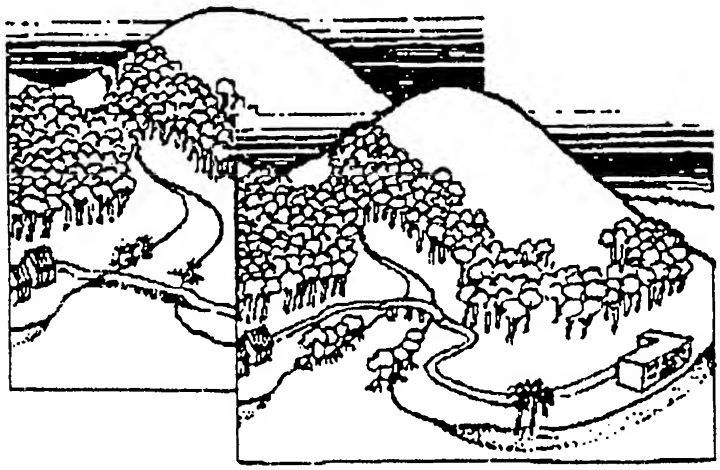
2. Present the following three cases to the students. (You could add more cases using local examples). In each case the island will be the same.

3. Divide the class into small groups. Each group should discuss one of the case studies using the following questions:

   - ❑ what effect will the unrestricted development have on the environment?
   - ❑ what restrictions should be imposed to prevent potential environmental damage?

4. Remaining in the small groups, the students should develop a role play to show the views and pressures on the people affected by the development projects. For example, in Case 1 the characters in the role play could be villagers, a government official and the developer of the hotel.

5. Each group should present the results of their discussions to the whole class. If any points are missing other groups could add further points. It is important to discuss the dilemmas in each case.



Case 1:

A company proposes to build a tourist hotel and a road on the island:
The hotel will bring in foreign money and provide employment for many local people. Some government people want to allow the company to build the hotel without any restrictions (A below). Other people want to impose some restrictions to protect the environment (B below).

(A) *No restrictions*	The company wants to build the road on a causeway over the river near the coast. The company proposes to pump raw sewage from the hotel into the lagoon.
(B) *Some restrictions*	The government proposes to make the company build a bridge behind the mangroves. The government proposes to make the company install a sewage treatment plant.
Environmental Effects.	Although it is less costly, option A is likely to have some serious environmental effects, such as: 1. The mangroves on both sides of the causeway could die due to the restricted water flow. If this happens, the catches of fish near the village will decrease and the village shoreline may erode. 2. Nutrient rich water from the hotel wastes may affect coral and other marine life in the lagoon. The longshore current may carry this polluted water near the village.

Case 2:

With more people and the village growing into a town, sewage disposal is a problem.

The question is whether to continue to release sewage into the mouth of the river or undertake some more expensive form of treatment.

Environmental Effects	Without sewage treatment, there will be continual release of raw sewage into the mouth of the river with probable pollution. This will affect the ecosystems of the immediate area and especially the fish and other marine life. With some basic sewage treatment and positioning of the sewage outfall pipe away from the mouth of the river, the treated sewage will be released into the longshore current and carried away.

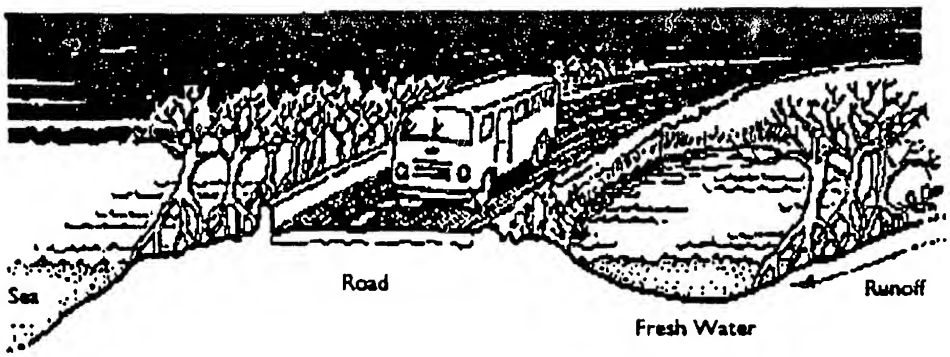
Case 3:

A forestry company proposes to export timber from the island.

The question is whether to allow the company to operate without any restrictions, i.e. letting it cut down trees near the river and not having a replanting programme. The other alternative is to impose some restrictions to protect the resource and the environment.

Environmental Effects	Trees cut down on the banks of the river may cause erosion and silt up the river with the result that mangroves may die and fish near the village may be killed or driven away. Without a tree replanting programme, the resource will soon be used up, leaving the soil exposed to erosion. A loading wharf may interfere with the longshore current and the village beaches will be eroded. However, government restrictions could include making the river bank area into a reserve, insisting that logged area be replanted with new trees and making the logging company build the loading wharf away from the village.

Further information on Case Studies of environmental degradation in the region are available from the South Pacific Regional Environment Programme (SPREP), P.O Box 240, Apia, Western Samoa. These are called *South Pacific Case Studies*, no. 1 - 5.



Activity 2: Miscellaneous Creative Activities

Material:

- ❑ Paper, colouring pencils/paints

Procedure:

1. After covering aspects of Environmental Pollution, these activities could be undertaken to reinforce concepts and give students the possibility to be creative and, of course, to have fun.

   - ❑ Write a letter to the editor of your local paper, or your president or governor or king, telling him/her why you think people should stop polluting the environment;

   - ❑ After a field trip, write a newspaper article, with a headline, telling what you saw and what people should know about it;

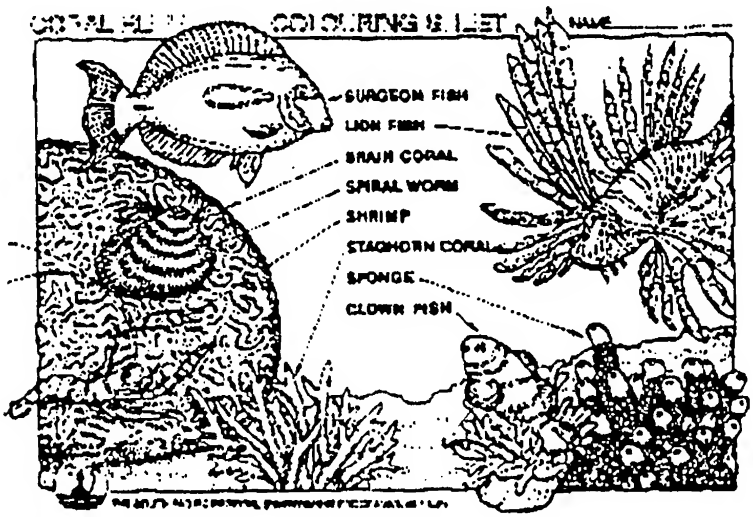
   - ❑ Design a stamp for National Environment Week;

   - ❑ Design a T-shirt with an anti-pollution message;

   - ❑ Draw a poster: "Down with Litterbugs",
     "Clean Air for All",
     "We Need Clear Water";

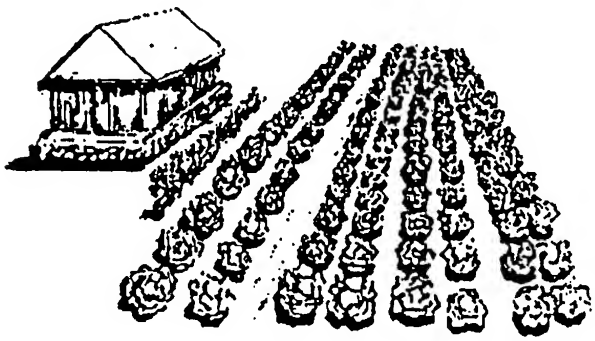
   - ❑ Ask your students to choose some colours that suggest clean and healthy (primaries and pastels) and some colours that suggest pollution (grays, browns, black, etc.). Get them to paint or crayon a picture in one set of colours. These can be displayed in the classroom and should present a nice contrast to highlight the visual effects of pollution; and

   - ❑ For younger students, printed blocks of colouring sheets (see example below) are available from the South Pacific Regional Environment Programme (SPREP).



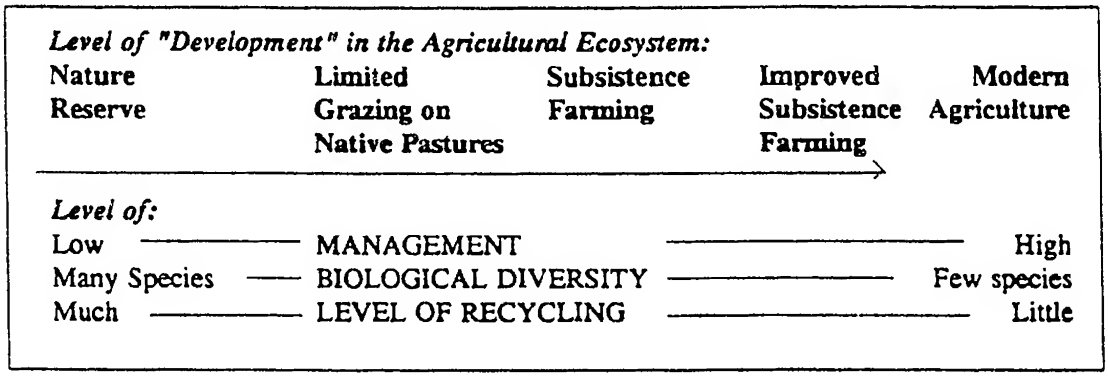
Unit Four:

Agriculture

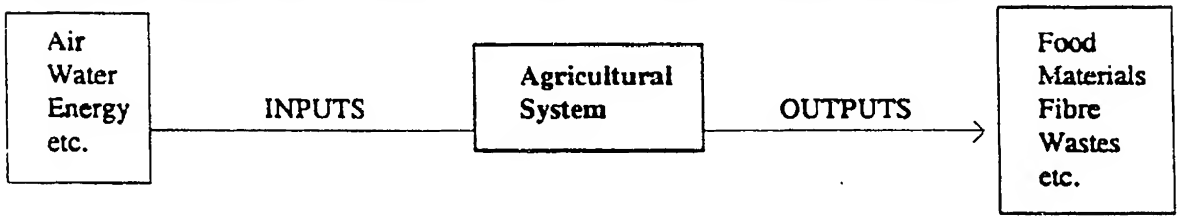


Introduction

We all depend on agriculture for food, fibre and materials. While it has become common to think of natural ecosystems as "good" and agricultural systems as "bad", this is not a very useful approach. It is better to think of a range of ecosystems which differ in a number of ways, including level of management, degree of recycling of energy and matter, and diversity of living things. This is shown in the diagram below:



An agriculture system may be considered in terms of inputs and outputs as a system shown below:



The agricultural manager decides what is to be produced (an output) and how it is to be produced. This means the manager has to regulate the type and level of inputs, e.g., fertilizer and pesticide use, as a result of monitoring the system and its outputs. This framework is useful in comparing agricultural land use and practices. The problems associated with modern agriculture can be related:

(i) directly to the nature of the inputs and outputs, e.g., pesticide residues in food, water contaminated by fertilizers;
(ii) to the long-term outcomes of farming in ways which are inconsistent with environmental stability. These include over-cultivation, soil depletion and increased problems with pests and diseases;
(iii) changes in the way in which people now live, e.g., changes in life style and nutrition.

Many Pacific Islanders live in an agricultural environment. They do not live in forests, in or on the ocean, or in towns. They depend on the agricultural environment, its soils, water, plants and animals for most of the things they need. If the agricultural environment is destroyed or polluted, then people will suffer.

Today, the agricultural environment in many Pacific Islands is breaking down because of over-emphasis on cash cropping for export and the national cash economy. As a result, more people are malnourished. They no longer produce most of what they need and now must import it from overseas at high cost. Many of the agricultural systems which have served Pacific Islanders for thousands of years are breaking down. Most of the environmental problems facing Pacific societies, such as pollution, soil erosion, deforestation, loss of species diversity, nutritional deterioration, cultural deterioration and loss of traditional knowledge, are found within the Pacific Island agricultural environment. So it is one of the best ecosystems for teaching the principles of environmental education and conservation.

Objectives

The objectives of this Unit are to show teachers how they can have their students understand that:

1. Most Pacific people are rural people who will live and will have to live in the agricultural environment;

2. Most urban people in the Pacific still depend on the agricultural environment, many still having extensive urban gardens;

3. Most Pacific Island agricultural environments are very complicated ecosystems containing many different soil types, water, many types of cultivated and wild plants and animals, most of which are very useful;

4. Agricultural systems serve very important ecological functions such as shade, erosion control, wind protection, animal and plant habitats, and soil improvement;

5. Agricultural systems still provide most people with most of their important needs such as money, food, drinks, medicines, housing, construction materials, dyes, toys, perfumes, decorations, as well as satisfying many other cultural and spiritual needs;

6. Current development trends, which stress cash cropping of single crops and which encourage urbanisation and the importance of cash employment, have led to the deterioration, pollution and destruction of traditional Pacific Island agricultural environments;

7. Current educational systems have been partly responsible for the deterioration in the Pacific Island agricultural environment, particularly in the loss of traditional agricultural knowledge, which is almost never taught in Pacific Island schools;

8. The deterioration of the Pacific Island agricultural environment, through soil erosion, deforestation and the neglect of tree planting, declining crop diversity, pesticide pollution, and overdependence on imported fertilisers, has very negative effects on people and the wider island environment;

9. The deterioration of the Pacific Island agricultural environment has been responsible for increasing poverty, widespread malnutrition, and increasing dependence of Pacific peoples on costly overseas sources for supplying their basic needs;

10. If Pacific Island agricultural environments are not conserved, there may be very little hope for real development; and

11. Changing demographic conditions, changing aspirations, and changing technology means that modern Pacific Island environments must conserve the best parts of the traditional agricultural environment with some cash crops and appropriate introduced technologies. These crops and technologies should not destroy the agricultural environment for short-term cash gains.

Teaching Goals

As part of these objectives, it is expected that students will be able to:

- ❑ describe some ways in which Pacific peoples, in both rural and urban areas, depend on the agricultural environment;
- ❑ describe the diversity of cultivated and wild plants and animals that make up their agricultural environment;
- ❑ describe the ecological functions of the agricultural environment;
- ❑ describe ways in which modern development has affected, or led to the deterioration of, the agricultural environment;
- ❑ describe what some of the negative effects might be if the Pacific agricultural environment is allowed to further deteriorate; and,
- ❑ describe ways in which some modern agricultural technologies can be integrated into the existing agricultural environment without leading to irreversible deterioration.

Background Information

The Problem of Agricultual Deterioration

Most Pacific Islanders live in the agricultural environment and because there are serious signs of the deterioration of this environment, it could be argued that agricultural deterioration is the most serious environmental threat to Pacific peoples.

Agricultural deterioration is almost universal throughout the Pacific. From the small coral-limestone islands like Nauru, where mining has almost completely destroyed indigenous agriculture, to areas of Papua New Guinea, where rapidly-expanding commercial coffee, oil palm, and rubber cultivation, and the introduction of village beef cattle schemes have made inroads into subsistence production, Pacific Island agricultural systems have deteriorated.

For Example:

On **Nauru**, where pandanus and coconuts were the staples, a combination of 70 years of open-cut phosphate mining and continuous bombing by both Japanese and American forces during World War II has made Nauruans almost totally dependent on imported foods. Of 19 known edible Pandanus cultivars, which are believed to be more ancient than coconuts on Nauru, and once covered the island, nine are now extinct.

In the **Marshall Islands** before World War II, the Japanese ordered the removal of breadfruit trees to increase copra production.

Throughout the Pacific taro cultivation, especially in the form of intensive irrigated-terrace, drained-swamp and excavated-pit taro cultivation, have declined drastically. On most islands, the predominant shift has been away from labour-intensive traditional staples, like taro and yam, to cassava, and, in the case of **Solomon Islands** and **highland New Guinea**, to sweet potato. Although possibly one of the only practicable local alternatives to increasing food dependency, cassava, has comparatively poor nutritional value, and seems to be at least indirectly responsible for declining soil fertility, increased erosion and general environmental disruption, due to its wide environmental tolerance.

The more general deterioration of agricultural systems is reflected in a general movement away from labour-intensive and land-extensive systems to labour-extensive crops such as cassava, and to cash-cropping cocoa, coffee and palms. Associated with this is the abandonment of tree planting and the destruction of existing trees which have considerable nutritional, cultural and ecological value. A decrease in mixed cropping a number of different staple crops with a wide range of supplementary food crops, and the halt to all-year-round planting, also affect the diversity and stability of traditional agricultural systems.

All of these factors are eroding Pacific Island self-sufficiency, and lead to poorer human nutrition.

For example:

Village cattle projects and coffee cultivation, and associated labour inputs and related activities such as increased beer drinking, gambling and consumption of imported foods, have severely eroded subsistence food production in the Papua New Guinea highlands.

With high world sugar prices in the late 1970s and early 1980s, Indian sugar farmers in Fiji began to abandon traditional practices of subsistence rice cropping, intercropping or cash cropping with legumes and other food crops, vegetable gardening, livestock production, and the protection of small grazing and forest reserves on their cane farms.

Deforestation, overgrazing, excessive and inappropriate ploughing and more use of inorganic fertilizers and herbicides have led to soil deterioration throughout the Pacific.

Deforestation, often due to repeated burning for agriculture, is widespread and is seen as the dominant factor responsible for the extensive montane and lowland grasslands of New Guinea, the niaouli savanna lands of New Caledonia, and the highly degraded "sunburnt" grasslands or talasiga found throughout Fiji. Deforestation had led to severe erosion, leaching, and laterization of Mangaia, Atiu and Rarotonga in the southern Cook Islands, and deforestation and resulting soil deterioration was probably responsible for the puzzling collapse of pre-European contact culture on Easter Island.

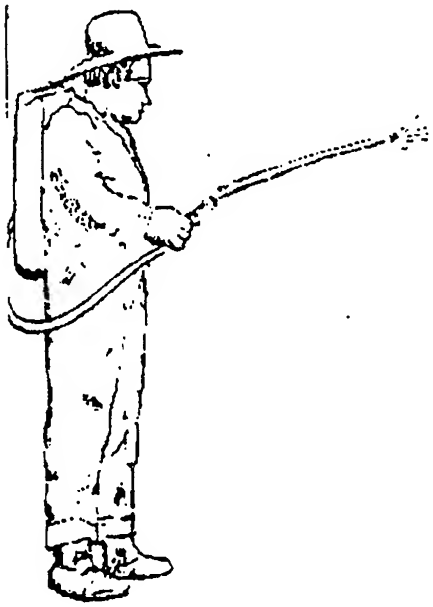
Overgrazing is also common in the Pacific and has led to severe soil erosion in New Caledonia, Hawaii, and on small dairy farms in Fiji. Large populations of wild deer, sheep and pigs have caused accelerated erosion in New Caledonia and French Polynesia, and the vicious circle of overgrazing and increasing soil erosion reduced Easter Island's sheep population from 60,000 in the 1950s to 10,000 in the 1980s. Widespread accelerated erosion in Papua New Guinea has also resulted from overgrazing on government-introduced smallholder cattle projects.

Persistent ploughing across the contours (using both bullocks and tractors) in Fiji and excessive ploughing in Tonga, the Cook Islands, and Hawaii have reportedly led to increasing erosion and compaction. On Niue, overuse and continual burning of organic material has "caused the soil level to drop" and brought soil depletion to a "crisis point".

Inorganic fertiliser use is rapidly expanding in the Pacific, and can greatly increase immediate crop yields. HoweSver, it seems to decrease organic matter and destroy its natural nitrogen-fixing ability in the soil. In the long-term, this will lead undoubtedly to more soil deterioration. **Indiscriminate use of herbicides** which is increasingly widespread, can also only serve to destroy valuable organic matter. An example is the use of the very toxic chemical "Paraquat" (RGramoxone), particularly widespread in taro plantations in Fiji and Rarotonga. In the latter case, herbicide use has reportedly led to subsidence and compaction in gardens that have served Cook Islanders for centuries.

The ***tropicalisation*** or ***islandisation*** of mid-latitude, continental agricultural technologies is often inappropriate. Mechanisation, the use of inorganic fertilisers, insecticides, herbicides and even imported foods and medicines have already been shown to be inappropriate. They depend on costly, imported, non-renewable fossil fuel resources, they put stress on the "tolerance margins" of nature and man, and they displace local labour.

Pesticides



Even worse, technologies such as hazardous pesticides, many of which have already been banned in some industrialised countries, are freely exported to the poorer countries despite their proven inappropriateness. Developing countries have become a "booming growth market", as well as a dumping ground, for pesticides considered too dangerous to be used in the countries where they are manufactured. The Pacific Islands are not free from this problem. Of the 585 pesticides reportedly "registered for use, used, or recommended for use" in the member countries and territories of the South Pacific Commission, 76 are banned or restricted for use in the United States or European Community countries.

Also of concern is the rate of pesticide poisoning in developing countries, which is 13 times that in the United States, despite greater use there. Although there is little data available, the situation seems to be the same in the Pacific where people either do not understand or do not read labels or warnings on containers; there are no unions or laws to protect farm labourers; there are few, if any, trained scientific personnel able to investigate pesticide dangers and malpractices; and recommended safety equipment is either too expensive or never used.

Perhaps the more important issue is that pesticides may never be successful in the long-run because of the severe ecological damage and disturbance they cause. Not only do they poison humans and cause soil and water pollution, they also usually destroy beneficial plants and animals and the natural predators of the very pests the pesticide user wishes to destroy. Many pests become resistant to these pesticides which means farmers have to use greater and greater amounts of increasingly toxic pesticides with possible adverse long term ecological impact. The farmers are on a "pesticide treadmill" that may never stop.

Epidemics of pests have considerable negative impact on future ecological and cultural development, especially where monocropping or large-scale livestock operations, and indiscriminate use of pesticides by humans are concerned. So they can be considered as management problems, although they may be partly related to a natural phenomena, such as after a severe cyclone.

For example:

In areas of Papua New Guinea and Solomon Islands the taro leaf blight (*Phytophthora colocasiae*) has almost eliminated the cultivation of the locally important staple *Colocasia* taro. Similarly, the Alomae and Bobone virus syndrome in Papua New Guinea and Solomon Islands, and Pithium corm rot in the Cook Islands, Hawaii and Western Samoa are very serious diseases to *Colocasia* taro.

In Kiribati, the Papuana taro beetle has made it very difficult to practice traditional pit-excavation planting of giant swamp (*Cyrtosperma*) taro, the only major staple root crop on many low-lying atolls. The beetle also reportedly restricts pit cultivation of bananas in parts of Kiribati. Sweet potato cultivation has been severely restricted in Pohnpei, Viti Levu (Fiji) and Tonga by epidemic outbreaks of sweet potato scab (*Elsinoe batatas*) and to a lesser extent by little-leaf microplasm. Yam production is commonly limited by periodic outbreaks of rose beetle and Anthracnose fungus.

Banana cultivation, mainly for export, but also as an extremely important local staple and fruit crop, is plagued by bunchy-top virus and black-leaf-streak fungus.....as well as the banana scab and root nematodes which have severely limited production in Tonga, Fiji and the Cook Islands and, in conjunction with hurricane damage, led to the halt of banana exports from Fiji in the late 1960s.

Insect infestations have also limited large-scale rice production in Fiji and the Solomon Islands. In Fiji, monocropping of the improved high-yielding variety became uneconomic in 1978 due to brown-plant hopper (*Nilaparvata lugens*) and leaf-roller (*Susuma exiqua*) infestations, which now cause significant damage to the new variety "bold grain" which replaced it. "Bold grain" production has now already become uneconomic due to pest predation in most areas, and is being replaced by newly developed varieties.

In Solomon Islands, the future of the large-scale (1978 hectares under cultivation in 1981) ultra-modern Guadalcanal Plains rice scheme is at stake due to the inability to control infestations of the same two insects, plus the seed shrimp and leaf-miners, despite excessive doses of a wide range of pesticides including the highly-restricted chemical •Parathion, which was responsible for 80 percent of Central America's pesticide poisonings. Parathion is considered "too toxic for use under most circumstances". Development of pesticide-resistant strains have exacerbated the problem, which has caused the cessation of exports and has restricted outputs for the local market.

Other pest infestations include the clogging of navigable waterways in Fiji by the aquatic weeds, water hyacinth and waterweed (*Hydrilla verticillata*) and infestations of a wide range of (exotic) introduced weeds, mostly of tropical American origin, like lantana and guava, which have rendered thousands of hectares almost useless. Nut-sedge (*Cuperus rotundus*), a scourge to intensive vegetable gardening and pickerel weed (*Monochoris vaginalis*), is common in irrigated rice fields, as are other noxious weeds.

Other destructive pests include rats, which carry disease and inflict very heavy damage to cocoa, coconuts, corn, sweet potatoes, peanuts, and watermelons; the Giant African snail in Solomon Islands, Tahiti and American Samoa; the giant cane toad in the Solomons and Fiji; the mongoose in Fiji and Hawaii; and the Indian mynah bird or starling in most islands. Unfenced feral and domesticated animals, particularly feral and domesticated pigs, cattle and horses, cause considerable damage to both commercial and subsistence crops throughout the Pacific.

There have also been periodic outbreaks of coccidiosis and a number of other poultry and swine diseases on large-scale poultry and pig farms, and New Caledonia has had severe infestations of cattle ticks. Such outbreaks have considerable negative impact on commercial livestock production, as well as necessitating the increasingly widespread prophylactic (preventive or protective, rather than curative) use of drugs in large-scale livestock operations. The development of these practices, for economic reasons, has led to the development and accumulation, in animals, of resistant bacteria strains, which are then passed on through the food chain to humans.

In short, the problems facing modern agricultural development and which relate to the deterioration of the agricultural environment in the Pacific Islands, could be summarised as:

1. **Poor and Unbalanced Nutrition** amongst urbanised and cash croppers, giving malnutrition, nutrition-related non-communicable diseases, and poisoning;

2. **Increasing Food Dependency** in urban, as well as many rural areas for human and livestock feed;

3. **Increasing Fuel Dependency**, with high-cost fossil fuels; and decreasing fuelwood supplies in agricultural and urban areas;

4. **Increasing Economic Dependency** on aid, remittances and trade;

5. **Technological Dependency** on machines, fertilizers, insecticides, herbicides, tools, seeds, processing, storage, etc.;

6. **Limited Local Markets** for agricultural produce;

7. **Limited and Unreliable or Unstable Overseas Markets** for cash crops such as copra, cocoa, coffee, sugar and bananas;

8. **Disease Infestations and Epidemics** in bananas, rice, cocoa, taro, sweet potato, watermelons and coffee;

9. **Natural Disasters** such as tropical cyclones, floods and drought;

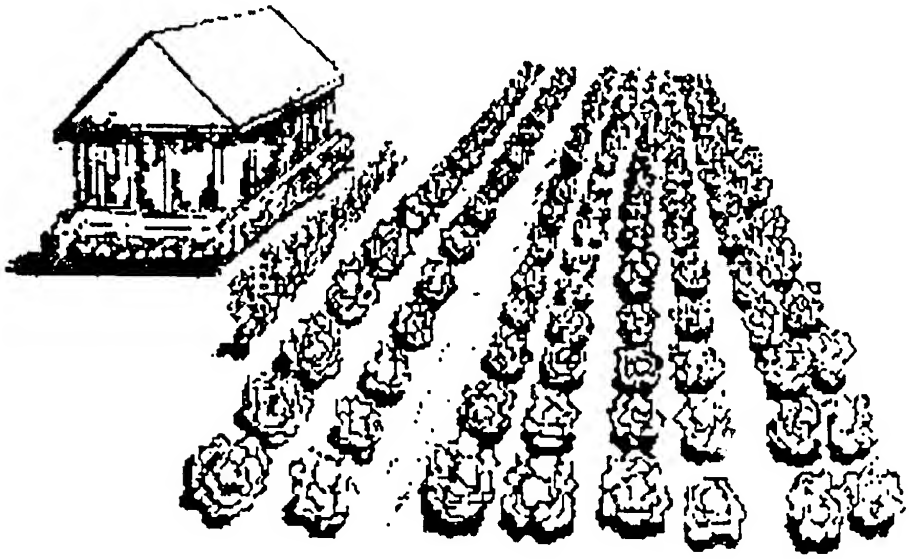
10. **Insufficient Infrastructural Development**, especially roads, wharves, air strips, storage or freezing centres, market places, and processing plants, which make it difficult to market and distribute agricultural products, and make access to agricultural inputs difficult;

11. **Poor Agricultural Extension Services**, which are often narrowly-focused and misinformed;

12. **Much Educational Dependence** on agricultural curricula from overseas and neglect of traditional agro-ecological education. Many students do not even know the names of their trees, that are a part of their own agro-ecosystems;

13. **Ecological Deterioration** through erosion, deforestation, leaching, laterization, soil and water pollution, and genetic erosion; and,

14. **Cultural Deterioration** with changes to the food system, loss of perfumes, deodorants, dyes, and other material goods, and loss of knowledge which accompanies agricultural change and deterioration.



Components for Unit Four

As most schools are situated in, or near, the agricultural environment, there are countless activities which could be used with students to teach them about the importance of good agricultural practices and the effect that its deterioration could have on Pacific societies. This area of study would seem to lend itself well to in-the-field activities and the use of older persons from the community, thus offering excellent opportunities to integrate traditional knowledge with modern scientific knowledge in the curriculum.

Suggested General Activities

The children could:

- ❑ draw maps of food gardens showing all cultivated and wild plants, and prepare lists of these plants with their ecological requirements, their cultural uses and ecological functions;
- ❑ make lists of all the different varieties of traditional staple crops such as yams, taro, sweet potatoes, bananas and plantains, breadfruit, and pandanus to highlight the concept of intra-species diversity;
- ❑ list ten medicinal plants, ten sacred or fragrant plants, ten plants used for parcelling food, and ten dye plants that are found in the agricultural environment, but which are now being replaced by expensive imported substitutes. This exercise could be done by the children asking their elders at home;
- ❑ collect, dry and mount specimens of ten cultivated plants, ten native wild plants, and ten introduced wild plants or weeds that are important to their society;
- ❑ make lists of local market products which come from the agricultural environment in their home village;
- ❑ write a short essay on what life would be like without the products from their traditional agricultural environment; and
- ❑ write an essay on how the traditional agricultural environment differs from the modern agricultural environment.

Resources

Resources could include:

- ❑ Community elders, both men and women
- ❑ People's farms
- ❑ Urban gardens
- ❑ Agriculture Department employees
- ❑ Local markets
- ❑ Non-government organisations
- ❑ Nutrition Section in the Health Department.

Activity1: Looking for Evidence of Erosion (Field Activity)

Material:

- ❑ None required.

Procedure:

1. Choose a time after reasonably heavy rain, and take the class out into the field to visit a nearby site or sites (garden and stream) as follows:

2. Look for deposits of very fine soil (silt) on the grassy sides of streams or in the bottom of pools of water at the sides of a stream where the water has been overflowing and has recently drained away. Ask the children where this silt has come from.

3. Inspect the logs or large roots or even large rocks that you see lying in the garden. Look at the ground on the high side of these objects. Are there any deposits of silt there? If so, what carried it there and where did the silt come from?

4. Ask if there are any newly made mounds or beds in the garden? Are they the same shape as they were before the heavy rain? If they are different what has changed their shape?

5. Look also for very tiny new water marks in the soil. Ask students how these have been made and where they think the soil has gone that once filled these spaces.

6. Follow tiny stream marks in the soil to see where they run to. Perhaps you could see where they have joined up with other small streams and perhaps where they have ended once the ground is level.

7. Look for tiny columns of soil where there is no vegetation cover. Quite often you can see these small columns of soil with very small stones on top of them. Ask the children why these columns are there. What made them? Where is the soil that previously filled the spaces between them?

8. You could also look at a soil surface that has been covered with mulch during the rain storm. Are there any tiny columns on this soil under the mulch? If not, why not?

9. Where did you find most evidence of erosion? In an area where there are plenty of plants growing and the ground is covered or in the areas where there is none or very little plant cover?

Note: The questionnaire contained in Activity 2 : Soil Erosion is a follow-up activity to this field trip.

(Activity adapted from *PNG Agriculture: Improved Subsistence Farming, Teachers' Guide*, Grades 7 and 8, Unit 1)

Activity 2: Soil Erosion (Classroom Activity)

Material:

- ❑ This activity builds on the children's observations in the field trip outlined in Activity 1.

Procedure:

In the classroom, as a follow-up to the field activity, ask the children to discuss these questions:

(a) Do roots and tree trunks and large branches lying in a garden help to hold the soil in place? Does mulch on a garden help to keep the soil in place? Is bare ground more likely to erode than ground with plants growing on it?

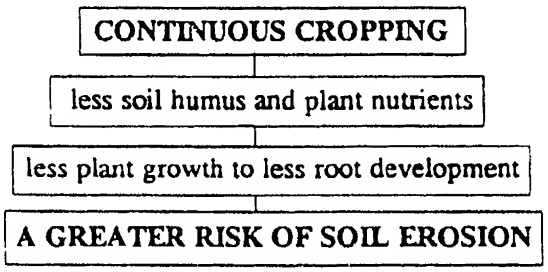
(b) Which of the following kinds of garden is more likely to have soil erosion problems after heavy rain: a steep sloping garden? or a garden on level ground?

(c) One farmer cleared an area of bush and removed all the tree stumps and roots before he planted. Another farmer cut the trees but left the stumps and roots. Which garden is likely to suffer most soil erosion?

(d) A school has been cropping an area for two years. The crop is getting poor. The teacher decides to plant a cover crop for one year to rest the soil. Another reason for planting the cover crop would be to stop:

-O-L -R-S--N *(Fill the spaces)*

Note: Soils that have low humus content are more subject to erosion than soils with a high humus content. Humus in the soil helps to bind small soil particles together and it also helps to produce healthy quick growing crops whose roots in turn help to prevent erosion. As the humus content is reduced so the risk of soil erosion increases. This direct relationship between soil, humus content and erosion is difficult to explain to students, but teachers can stress the point that humus makes healthy plants and healthy plants prevent soil erosion. Teachers could use the following diagram on the blackboard to discuss with the class the relationship between continuous cropping and increased soil erosion.



(Activity adapted from *PNG Agriculture: Improved Subsistence Farming, Teachers' Guide*, Grades 7 and 8, Unit 1

Activity 3: Soil Use and Water Holding Capacity

Soil structure depends on the kind of particles present (sand, salt or clay) and the way in which they are grouped together. When soil is over-used its structure breaks down and its properties change. One important property is water-holding capacity. Students should compare the water-holding capacity of soils in agricultural use in their environment as follows.

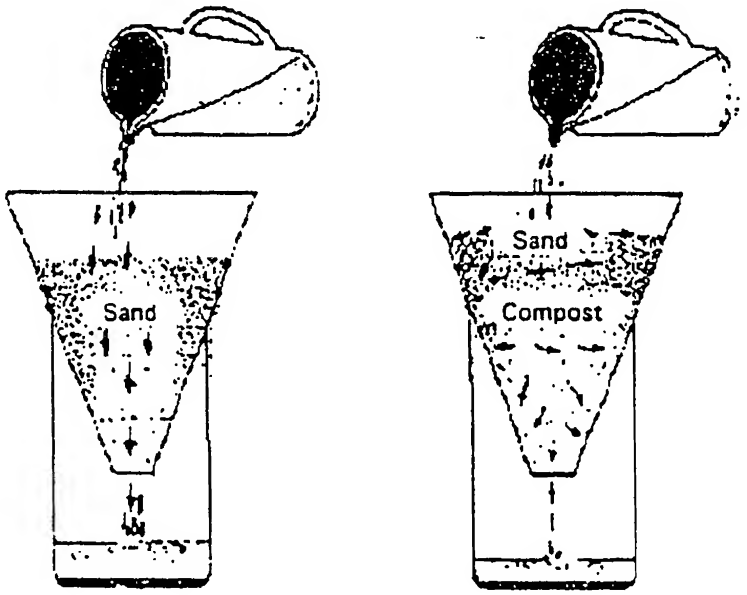
Material:

- ❑ 2 glass breakers (or jars)
- ❑ 2 funnels
- ❑ 1 jug filled with water.

Procedure:

1. Make two large funnels of the same size and place them over the glass, jars/breakers then fill each funnel with a different soil.

2. Pour water into each and see which funnel holds the most water.



(Activity adapted from *PNG Agriculture: Improved Subsistence Farming, Teachers' Guide*, Grades 7 and 8, Unit 1)

Activity 4: Talking to Farmers

Material:

- ☐ None required.

Procedure:

Farmers love to talk about what they do on their farms. Have the children talk to farmers who practice mixed cropping, where culturally possible. As a result of this activity, students should be able to list some of the advantages and disadvantages in a similar way to that shown below:

Advantages of Mixed Cropping:

1. There are small numbers of each type of plant so there is little chance of a large build up of pest numbers or disease.
2. The farmer is more likely to see damage or disease and deal with it quickly.
3. Farmers do not stand to loose a large amount of money if they have small amounts of different crops even if one type is wiped out by a pest or disease.
4. There would be a greater chance of an enemy of a particular pest or disease being present in a mixed garden.
5. There is less chance of the disease spreading to other areas.
6. It is possible to Control the pest or disease by removing it by hand.

Disadvantages of Monocropping (Single-Cropping)

1. You can very quickly get a build up of a pest or disease in a short time because there is plenty for the pest or disease to feed on.
2. The farmer is not likely to see the pest or disease until it is well established.
3. The losses can be large. The farmer could lose the whole crop.
4. There is less chance of enemies of the pest or disease being present in a place that only has the food of the pest or disease growing there.
5. If there is a big build up of a pest or disease in one area it has more chance of spreading to other areas.
6. Control by spraying is very costly.

(**Activity** adapted from *PNG Agriculture: Improved Subsistence Farming, Teachers' Guide*, Grades 7 and 8, Unit 1)

Activity 5: Pests and Diseases

Pests and diseases are not only a problem for farmers and gardeners - they affect us all. In this activity students will gain first-hand experience of the complex interactions between living things and their environment.

Material:

- ❑ None required.

Procedure:

1. Find out from the children, what "monocrops" are grown locally. It might be coffee, coconuts, tea, pyrethrum, cabbages, vanilla, cocoa, ginger or some other popular cash crop.

2. Try to organise a visit to at least one place that has a large monocropping area. Inspect the leaves of the crop for insect, bacterial or fungal damage.

3. Ask, if possible, to have the person in charge of this area answer the children's questions about pest and disease problems.

4. Suggest they ask the following questions:

   (a) What is the name of a disease or pest that attacks these plants?

   (b) Can you show us a badly damaged one?

   (c) How do you cure the disease or kill the pest?

   (d) What are the other ways you could use?

   (e) Do you use sprays?

   (f) If so, how often do you spray?

   (g) What does the spray cost?

   (h) Is the pest or disease bad all the time, or only at particular times of the year?

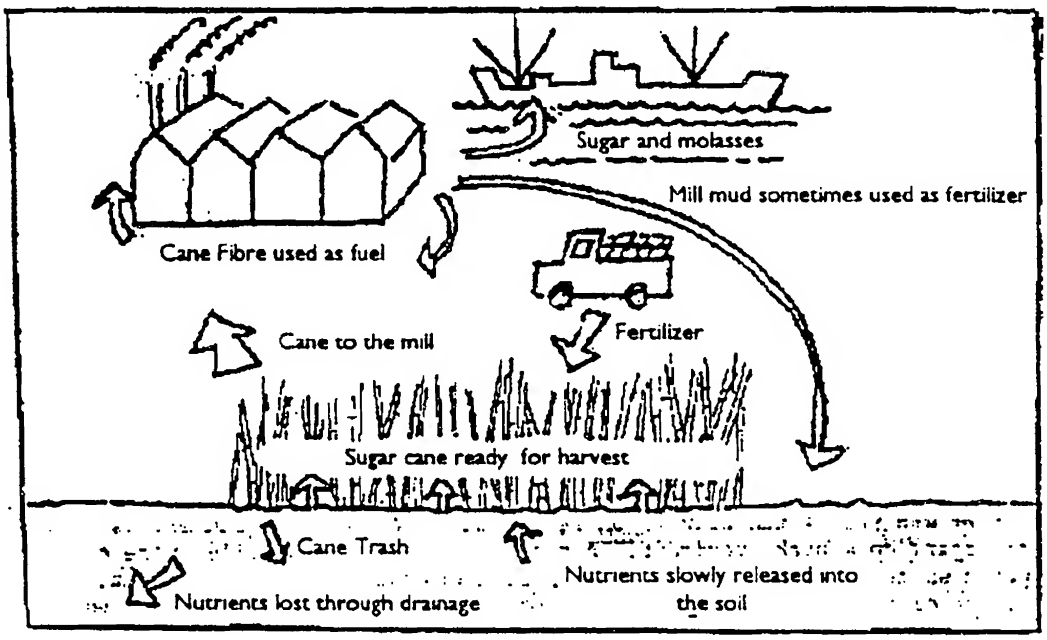
   (i) Are all plants affected, or only some?

   (j) Can you get plants that are resistant to attack?

(Activity adapted from *PNG Agriculture: Improved Subsistence Farming, Teachers' Guide*, Grades 7 and 8, Unit 1)

Activity 6: Recycling

Natural ecosystems usually have a high rate of recycling. As we have changed the environment to produce more of the things we want, the rate of recycling has been changed. The recycling of nutrients in a modern cane industry is shown below.



Nutrient Cycle on a Cane farm

(Width of the arrows show the amount of nutrients moving)

Material:

- ❑ None needed.

Procedure:

1. Visit a farm or garden and investigate all the ways in which recycling takes place. It would be good to include a subsistence farm, an improved subsistence farm, a modern farm and also different levels of production.

2. Draw a diagram of what you find, like the one above.

Activity 7: The Man-Made Environment and Agriculture

The man-made environment connected with agriculture concerns all the man-made rules, laws and customs of society which affect it. The man-made environment in this case does not refer to houses, towns and cities although both concepts are connected. You must ensure that students can separate in their minds people's physical effect on the environment (houses, towns, roads and bridges) and their social effect on the environment (laws, trade, services and social attitudes).

Agriculture is an industry which is important to everyone. People who live in towns and grow none of their food are all dependent on farmers for their food. As a country changes from one where most families grow their own food, to one where more and more people grow no food at all, then it follows that people who still grow food must grow more of it.

Material:

- ❑ None required.

Procedure:

1. Discuss with students the products a farmer may want to sell and the things he may want to buy. Use as an example a farmer from your own area. Expand this idea by asking what might happen if the public wanted something else that the farmer could, but until now had not grown. Would the farmer grow it? Would it pay him? How would this affect the farmer's needs? Try to establish the idea that the farmer's decision about what to grow is not entirely his own decision. Other factors, for example the needs of the people he sells his produce to, also influence his decision on what to grow.

2. Discuss with the students why agriculture is becoming more important as a result of development. Start with the local area. You could ask questions such as:

   (a) what percentage of local people grow none or very little of their own food?

   (b) what do they work at instead of growing food?

   (c) where do they spend their money?

   (d) do any of the farmers in the local area get any of this money?

   (e) what percentage of subsistence farmers in this area grow only food for themselves and their families.

(Activity adapted from *PNG Agriculture: Sub-Unit 2.2, The Man-Made Environment*)

Activity 8: Changing the Environment for Agriculture

The most important reason for altering the natural environment is to produce food required by man.

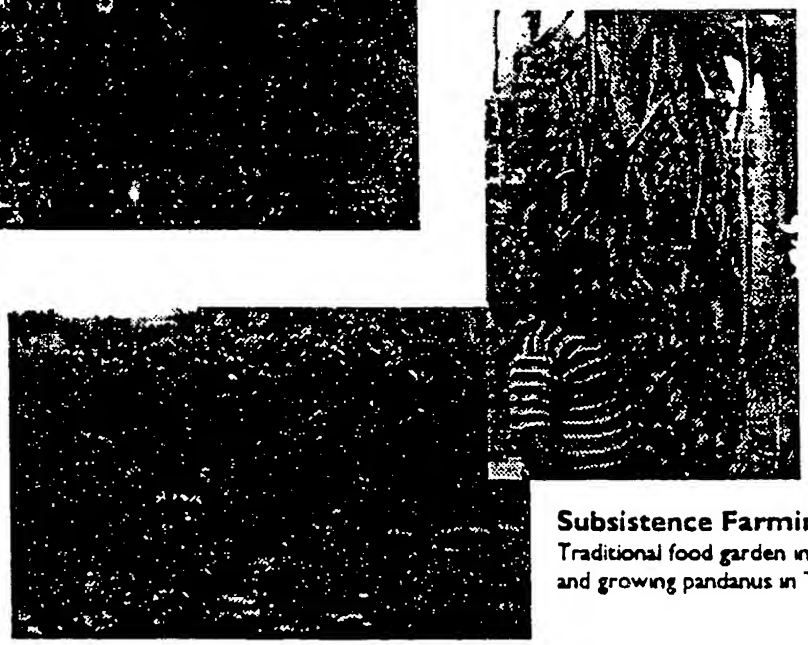
Material:

- ❑ None required.

Procedure:

1. Talk to the students about altered environments and show them the pictures below.

Modern Farming:
Ploughing with a tractor in Tonga



Subsistence Farming:
Traditional food garden in Western Samoa (left), and growing pandanus in Tuvalu (above).

2. The pictures of the large open area shows complete destruction of the natural environment. The pictures of subsistence farming shows very little destruction of the natural environment. There are some points below that can be discussed with the class to emphasise the "distance" each type of system has departed from the natural environment.

   - ❑ Which system uses the most artificial fertiliser and why? (Very likely the monoculture, Picture A, because here the farmer continuously crops the same area every year. If he is continually taking food from the land without a rest, then he must continually put something back in the form of fertiliser. In Picture B, something is taken from the land for one or two years and then it is allowed to rest and recover. Little or no fertiliser is needed. Because the bush is so near it recovers quickly.)

- ❑ Which system is most likely to lose soil in high wind, or in a flood? (The system in Picture A. There is nothing to slow the wind or water down. If the land is newly ploughed and cultivated, a lot of soil might be lost.)

- ❑ What precautions could the farmer in Picture A take to reduce soil erosion? (He could plough, cultivate and plant, at a time when there is less chance of high wind or flood. He could plant cover crops between main crops to keep the ground covered most of the time. He could plant rows of trees at intervals over the area.)

- ❑ Which system would be most expensive in terms of labour costs? (It depends on how you work it out. If you count the cost of expensive machinery as labour then system A is expensive. If you count a person's physical work for every square metre then system B is the most expensive.)

- ❑ Which area could most quickly return to the natural environment again? (The area in Picture B because the bush is so close. It could take hundreds of years for the area in Picture A to return to bush, or it might never return to the type of bush it once was.)

- ❑ Which is the least reckless (risky) system if we think about disasters like heavy floods or very high winds? (Obviously the system in Picture B. We should remember also that the system in Picture A could have high money rewards as well as greater risk.)

- ❑ Which system could produce the most food per hectare? (Probably the system in Picture A but then we have to consider other things such as how much fertiliser and machinery is needed. Maybe the system in Picture B is better if you want variety of crop without any expensive inputs. It all depends on why you are farming.)

Note: The above questions are asked to stimulate discussion and to encourage students to think. Please remember the answers given here are not necessarily the only answers.

The teacher could sum up with the two main points below:

(a) The larger the area cleared for cultivation, the more work, care and skill it takes to manage it.

(b) The larger the area cleared and the more specialised the crop, the greater are the risks of disaster or failure. The rewards are usually greater also.

3. Try to obtain other pictures of farming systems such as rice paddy fields, coffee gardens, coconut plantations, etc., and compare these in terms of risks and costs involved and their "distance" from the natural environment. The "distance" from the natural environment of any farming system is really a measurement of time. It is the time the land would take to revert back to the natural environment of the area if farming were stopped. Some large areas which have been used for monocropping might never return to the natural vegetation. A small subsistence garden surrounded by natural bush can revert back to complete bush within a year or two.

(**Adapted** from *PNG Agriculture: The Environment Teachers' Guide*, Grades 7 and 8, Unit 2)

Activity 9: Comparing a Bush and a Cultivated Area (Field Activity)

(Extension for Activity 8)

Material:

- ❑ None required.

Procedure:

1. Take the students into the bush for one period of their time and to a cultivated area of land for another period.

2. Remember: the best way to control a class and get the most out of an excursion such as this is to keep them busy. You cannot supervise them all or talk to them all at the same time, so they must be well informed about what is expected of them before they leave the classroom. Preferably the students should have some written instructions or questions with them on the excursion.

3. Below is a list of things which the children could observe, record and compare between a bush area and a cultivated area. Teachers should select, add to or alter these to fit the areas they intend taking their classes to:

   - ❑ The depth of cover from ground surface to the top of the vegetation layer.
   - ❑ The percentage area of the ground covered by shade, or alternatively, the percentage of sunlight.
   - ❑ The number and variety of insects and small animals seen during the visit.
   - ❑ The number of different species of plants observed (these could be counted for a small area).
   - ❑ The approximate air temperature in the shade.
   - ❑ The soil - its colour, depth, moisture content, amount of humus, temperature taken in the shade at about 5cm deep.

4. Arrange the children in small groups and give each group a specific task to complete. There is no need for all students to take all measurements. It is better if the work is shared and results from different groups discussed in class. Perhaps you could arrange for a wall chart to display the combined results comparing the two areas. Care must be taken so that the physical conditions are (as nearly as possible) the same when you visit each area. It would be a waste of time, for example, comparing the soil temperature in the bush when it is sunny and warm with the cultivated area soil when it is wet and cloudy. The results of this comparison will, of course, depend on the areas you compare but generally you should find the following results and be able to make the following conclusions:

   There is a much greater mass and variety of vegetation and animals in an area of natural environment than in a cultivated one. Nature has a way of using the environment much more efficiently than man can ever do. Farming is necessary because the natural bush does not provide us with enough of the kinds of plants and animals that we want to eat. Bush soil is cooler, has more humus and is therefore darker, and holds more moisture than equivalent soil in a cultivated area. This is because it supports a greater mass of vegetation and it is covered by a layer of leaves.

(**Activity** adapted from *PNG Agriculture: A Handbook on Soils for PNG*)

Activity 10: Soil Deterioration

If soil is not used wisely it deteriorates. An important indicator of this change is the texture of the soil. For instance, many loams deteriorate to heavy soils.

Material:

- ❑ Soil Samples (see below).

Procedure:

1. Take a small sample of soil from places where you think the soil has been used well and also overused. Take only about a teaspoon full and moisten it with a few drops of water and work it in the hand until it goes like stiff mud. It is important that the soil, when ready for testing, should be neither too wet nor too dry. It should not be sloppy, but it should be wet enough to mould. Once the soil sample is ready for testing, it can be tested in three ways, as follows:

   - ❑ by rubbing a small portion of the soil between the thumb and first finger and listening to the sound it makes and sensing the feel;
   - ❑ by squeezing the soil between the thumb and first finger to form a ribbon and then observing;
   - ❑ by moulding the sample, first into a ball, then into a thin worm shape and finally see if the "worm" can be bent into a circle of about 18 mm diameter.

2. The table below shows how the results of the above three tests are interpreted to give the soil textural class.

3. Compare the textures of soils and relate them to the way in which they have been used.

(**Activity** adapted from *PNG Agriculture: A Handbook on Soils for PNG*)

	Behaviour of the Soil Paste		
Feel and Sound	**Between Fingers**	**Cohesion and Plasticity**	**Soil Texture**
Feels Gritty	Fingers not soiled after drying	Nil	Sand
Rasping Sound	Fingers soiled	Will not form a cohesive ball	Loamy sand
Grittiness is slight or absent. Raspy sound.	Ribbon is coarsely cracked	Will form an cohesive ball, soft and pliant	Sandy loam
Silky feeling (slight to pronounced)	Ribbon is traversed by fine cracks	Ball is firmer, but fairly easily deformed. Worm will not form a circle.	Sandy clay loam
Very smooth and sticky	Ribbon is polished	Moderate resistance to moulding. Worm forms a without a fracture.	Clay loam
		Marked resistance to moulding. Very plastic.	Clay

Activity 11: Soil Infertility

This activity is suitable over a long time period only, e.g. in a school garden plot.

Soils become infertile when they are cropped year after year, the crops are removed, and none of the residues is returned to the soil. In this activity, students can repeat a "discovery" by early man that potash (potash is the common name for the element potassium) when placed on gardens which had been in use for years, resulted in improved crops.

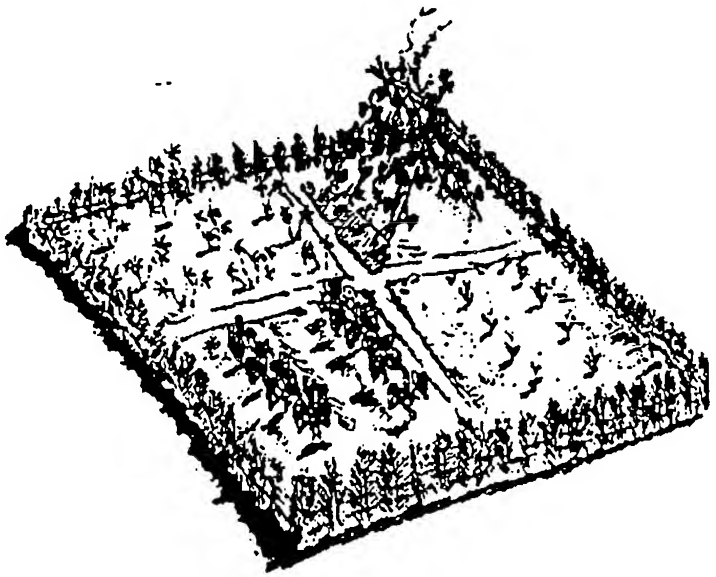
Material:

- ❑ School garden and plants
- ❑ sources of potash

Procedure:

1. Collect potash from a variety of sources.
2. Mix them together.
3. Add a small amount to vegetable crops leaving some areas untreated as a comparison or control.
4. Compare and contrast the treated and the untreated vegetable.

(**Activity** adapted from *Managing Soil Fertility*, ASMP, CDC Canberra)



Activity 12: Clearing Land for Agriculture

Most of the land which has been cleared, has been used for agriculture. In this activity, students are invited to study the immediate and long-term effects of such clearance as suggested below:

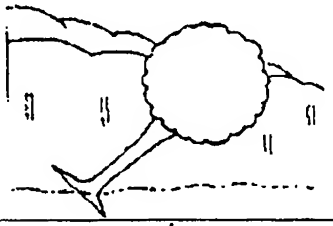
Procedure:

1. On the chalkboard go through this activity, asking the class to give suggestions for short and long-term effects of clearing land for agriculture.

Effects of Felling One Tree

A forest is made up of many trees

What are the effects of felling one tree in the area?



Example
Selective logging - small-scale operation with removal of, or damage to, a very small percentage of trees (e.g., 5 - 10 %)

Immediate Effects

1. Animals which depend on the trees die or move away.
2. The tree no longer produces seeds.
3. The place where the tree was is open to the sunlight.

Long-term Effects

1. Animals breed and replace those that have died or moved away.
2. Other trees of the same species can supply seed.
3. Sunlight can reach young seedlings which will grow quickly in the place of the tree.

Original Forest Restored in a Few Years (e.g., 15 to 30 years)

The Effects of Clearing a Large Area

What are the effects of cutting down large areas of trees?

Example: Clear felling

Immediate Effects

1. Large numbers of animals die.
2. Seed trees in area are dead.
3. Large area is open to sun, wind and rain.

Long-term Effects

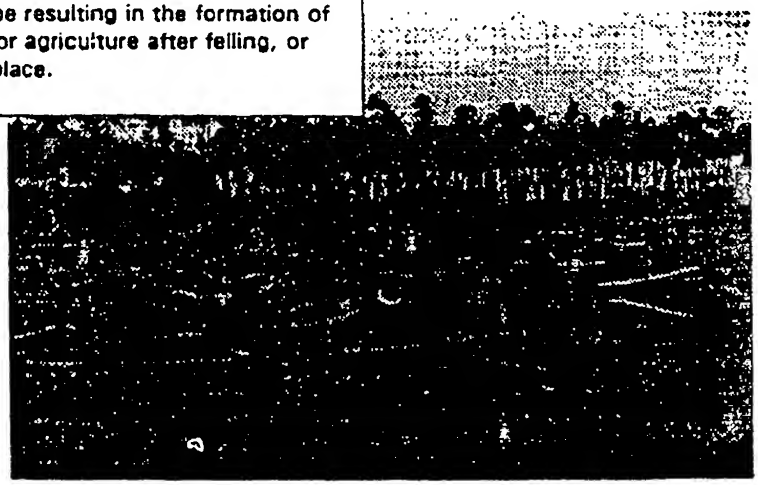
1. There will be fewer types of animals in the area.

   Some species will never return.
2. Seeds left in soil will grow if they favour open sunlight.

   Grass and creepers will grow first.
3. Sunlight will heat the ground. It will [illegible] down humus, making soil more infertile. It will dry the soil, and wind may carry it away. Rain will wash away the topsoil. Nearby creeks and rivers will be muddy. Soil may be compacted (= become hard.)

Either:
Slow return to forest of a secondary type, with poorer representation of plant and animal species. Full recovery to a high forest may take several hundred years.

Or:
Destruction of the landscape resulting in the formation of grasslands if land is used for agriculture after felling, or if too much erosion takes place.



Unit Five:

Traditional Knowledge

Introduction

In the Pacific, traditional knowledge is knowledge that existed in Pacific societies before contact with Europeans. This knowledge is passed on by word of mouth, through experience and observation, and sometimes through formal instruction.

Pacific Island societies are changing, and modern technology is playing a part in this change. It has become important to look closely at these new technologies, because of the extra demand they often place on fragile island environments, coupled with ever-growing populations on these islands. Pacific islands share an "isolation" and high endemicity of flora and fauna, and so these demands from modern living must be weighed against the loss of the environment and the natural resources it provides to Pacific islanders. Perhaps it is time to explore the traditional knowledge, skills and practices used to conserve the fragile Pacific island environment, and to save those which have proven most effective.

Why is Traditional Knowledge Important?

Traditional knowledge is worthwhile in itself as knowledge. Research has shown that it embodies understandings of ecological relationships unknown to modern Western science. For example, the knowledge and practices used by Palauan fishermen for centuries share similar principles to those in modern marine biology. Other researchers have found that local systems of classifying plants in many Pacific islands have more categories than the corresponding modern scientific taxonomy.

Traditional knowledge expresses values. For example, love of the land is a common traditional value embodied in proverbs, legends, and ceremony. Traditional knowledge may involve explicit or overt action, e.g., protecting fisheries by persons authorised by custom to act as conservation officers and to enforce regulations. Conservation may also result from traditional behaviour without any apparent conscious intention of environmental preservation, e.g., ritual warfare, pig husbandry and feasting are means of ensuring land fallowing in Papua New Guinea.

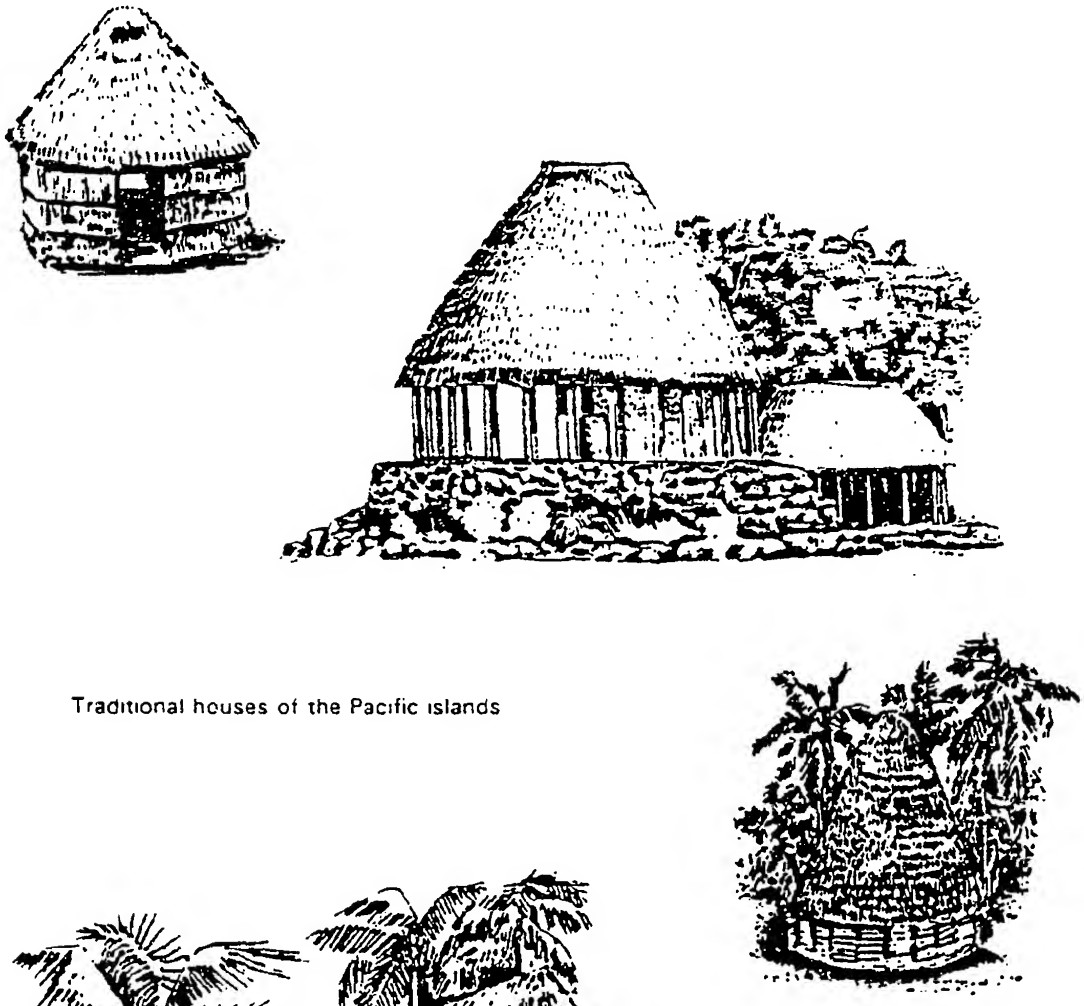
The State of Traditional Environmental Knowledge in the Pacific

A survey was carried out in 1988 on a group of teachers and curriculum developers participating at the Environmental Education Curriculum Development Workshop at Suva, Fiji. It was found that there was a wide range of traditional knowledge suitable for incorporation in school curricula. However, some were concerned about the ability to effectively learn about some traditional environmental protection practices. In this regard, there is great variation within and among countries in the region. In some areas, there are extensive written modern resources but little traditional knowledge among the general population. Elsewhere, traditional knowledge is limited to the elderly and traditional experts, with few written resources.

Generally, traditional environmental knowledge is being lost everywhere. This trend could be stopped by incorporating the study of this knowledge in school curricula and in teacher training. However, it should be explicitly recognised that some traditional knowledge is private or restricted, and so cultural sensitivity is essential in curriculum development, teacher training, and in classroom and field activities.

Components in Unit Five

The overall aim of the unit is to show how traditional lifestyles depended upon the immediate environment, and to increase awareness and understanding of changes occurring in the rural environment versus the urban environment.



Traditional houses of the Pacific islands

Activity 1 : Understanding Cultural Change

Material:

None required

Procedure:

1. The teacher could discuss with the children the meaning of "cultural change" or "changes in tradition".

2. Divide the class into groups, making sure there is a balance of students from the urban environment and the remoter rural environment. Allow the groups to elect a leader and a recorder, and to discuss the following questions in 20 minutes before reporting back to the rest of the class. Students are to imagine that they live in a:

   - town, and
   - remote village environment with a basically traditional lifestyle.

   ❑ Food
   (a) What type of food do you eat for breakfast, lunch and dinner?
   (b) Who makes the food available?
   (c) Where is the food taken from?
   (d) What type of tools or resources are necessary to get the food?
   (e) Where do the tools or resources come from?

   ❑ Food Preparation
   (a) How is the food prepared (e.g. boiled, lovoed, umued, baked or solar dried?)
   (b) How long does it take to prepare dinner?
   (c) List everything used in preparing dinner (e.g., firewood, pots, gas, coconut leaves, and banana leaves.)

   ❑ Medicine
   (a) When you cut yourself badly on the foot with a piece of broken bottle, where do you go for treatment?
   (b) What type of treatment is given?
   (c) Who treats your foot?
   (d) List the things used to treat your foot.

   ❑ Songs and Dances
   (a) List three favourite songs.
   (b) Are they traditional folk songs in the vernacular or English songs?
   (c) What are the songs about? (e.g. flowers, the land, love songs, etc.)
   (d) What is the reason for liking the songs?
   (e) What music do you like dancing to?
   (f) How many traditional dances can you dance?

Alternative:

Are there any songs about children, families or village events? Or about the land, the sea, or conservation, or village or community history? Explain what the song tells.

3. The teacher should lead a discussion highlighting the differences and similarities between the urban/town case study and of the remote/rural case study.

4. The teacher should lead the class to discuss how the needs of each depended upon their surrounding environment and the extent of dependency on available environmental resources.

Extension Activity:

The teacher could ask the students to answer questions comparing the old and new ways (as above) for specific activities such as:

- ❑ fishing
- ❑ building houses
- ❑ handicrafts and household ornaments
- ❑ gardening
- ❑ entertainment

Ask old person from the village to relate a typical day in his/her early life, including the typical diet, and the forms of entertainment and games.

Activity 2: Traditional Fishing Methods

This activity aims at identifying some local traditional methods of fishing and traditional fishing gear, and to investigate their value to current fishing practices.

Material:

- ❑ Chart showing local traditional and modern fishing methods.
- ❑ Any available local fishing gear: modern and traditional.

Procedure:

1. The teacher should prepare a chart showing local traditional and modern methods of fishing.

2. Organise the children to bring some local fishing gear used today to the classroom and, if possible, older traditional gear.

3. Invite a local fisherman to talk about the values of both fishing methods.

4. Class Project: Divide the class into groups, assigning each group one of these tasks in finding out about modern and traditional fishing in:

   - ❑ the lagoon,
   - ❑ the outside reef, and
   - ❑ the open ocean.

   Have each group prepare charts and notes for a fifteen-minute talk for the rest of the class.

5. Ask the students to find the names of local plants, animals and birds used to make some of the traditional fishing gear, e.g., fish traps.

   Fill in the table:

Name of Local Material	Name of the Traditional Gear
Plant:	
Animal:	
Bird:	
Shell:	
Corals:	

Activity 3 : Investigating Traditional Uses of Plants

This activity aims for students to learn the scientific and local names for plants found near the school, and to learn their past and present values.

Material:

None required

Procedure:

1. Identify a range of plants in the school yard.

2. Identify their scientific and local names and their current and past uses, e.g., for:

   - ❑ food or beverage
   - ❑ medicine
   - ❑ ornament/cosmetic
   - ❑ housing
   - ❑ weaving
   - ❑ fuel
   - ❑ spiritual
   - ❑ dance or arts
   - ❑ ceremony

3. As a homework assignment, have the children ask family members or neighbours to identify past uses of these plants.

4. In class, have the children discuss and compare their uses, with the discussion leading to conclusions on the value of these plants and their conservation.